# DOWNSIDE RISK CONSTRAINTS AND CURRENCY HEDGING IN INTERNATIONAL PORTFOLIOS: THE ASIAN AND LATE-2000 CRISIS

A Thesis

by

YING ZHOU

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

December 2010

Major Subject: Economics

Downside Risk Constraints and Currency Hedging in International Portfolios: The Asian and Late-2000 Crisis

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Approved by:

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| Co-Chairs of Committee, | Dennis Jansen |
| | Ryo Jinnai |
| Committee Members, | Daren Cline |
| Head of Department, | Timothy Gronberg |

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# ABSTRACT

Downside Risk Constraints and Currency Hedging in International Portfolios: Asian and Late-2000 Crisis. (December 2010)

Ying Zhou, B.A., Chongqing University;

Co-Chairs of Committee: Dr. Dennis Jansen
Dr. Ryo Jinnai

MV is the traditional method to treat international portfolio selection problems, which bases its theory on the assumption of Normal Distribution. However, during economy recession the portfolio return turns out to be a fat tail distribution. Therefore, in this sense, we explore Roy's SF criterion and apply the extreme theory to the historical data. We demonstrate how such portfolios would perform during the Asian Crisis, IT Bubble Bust and the Financial Crisis separately. We also compare the SF portfolio's performance to the MV portfolio's performance, therefore to check, SF and MV portfolio, which will outperform during bust and boom of the economy. The Asian Crisis was marked with great currency devaluation and lower currency return on equity. The Dot.Com Bubble Busts was known for its sharp plummet in the stock market, while, the Financial Crisis was known as the large falls in the US stock market and elsewhere. They are the extreme events of the world capital markets, which in some way contribute to the non-normal distribution.

Simulated results over the 1997-2010 period which include six busts and booms: the Asian Crisis, period after Asian Crisis, IT Bubble Bust, period after IT Bubble Bust, The

Financial Crisis and period after The Financial Crisis, indicate that SF portfolio outperforms MV portfolio during most of the times, this result is especially obvious for Indonesian and Thailand.

# DEDICATION

To my parents

# ACKNOWLEDGEMENTS

I have been unusually fortunate to have had such generous and essential assistance from my committee co-chairs, Dr. Dennis Jansen and Dr. Ryo Jinnai, committee member, Dr. Daren Cline, I thank them for their guidance and support throughout the course of this research. Especially, I want to thank my advisor, who is also my committee co-chair, Dr. Jansen, who supported me through all the hard work. When I was frustrated, he gave me courage, and when I was confused, he lead me out of the confusions.

Thanks also go to my friends and roommates and the department faculty and staff for making my time at Texas A&M University a great experience.

Finally, thanks to my parents for their encouragement and to my boyfriend, Boyang for his encouragement and love.

# NOMENCLATURE

| | |
|---|---|
| CAPM | Capital Asset Pricing Model |
| COV | Covariance |
| GEV | Generalized Extreme Value |
| MV | Mean Variance |
| SF | Safety First |
| STD | Standard Deviation |
| VAR | Variance |

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# CHAPTER I

# INTRODUCTION

The Financial Crisis of 2007-2010 had resulted in large downturns in global stock market. 2006, the collapse of a global housing bubble in U.S. market caused the values of securities tied to real estate price to plummet, the damage to the investors' confidence created a deep impact on the global stock market. Investors suffered great loss during late 2008 and early 2009. The sad thing is that the history is always repeating, in fact, date back to 1997; Indonesia, South Korea and Thailand are the three countries that mostly affected during the Asian Crisis. The Asian Crisis Started in Thailand with collapse of Thai Bait. One of the reasons that the crisis showed a wide spread across the world is because of the increasing development of international diversification of portfolios. By Paul Krugman's view, the world is flat; it's no longer appropriate to think about any causality in financial market to treat a market as an individual unit. Just like an elegant universe, there are always some beautiful principles underlying the daily phenomenon. However, what are such principles under the international portfolio selections? Is there a better way to tackle with international portfolio selections in Crisis? That's the task of this thesis.

The rapid increasing of investment globalization also gives rise to the currency hedging issues. A lot of research has been done to show that the exchange rate returns are fat-tailed. For example, Martien and Casper(1991) has used a nonparametric method

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This thesis follows the style of *Applied Economics Letters.*

to test the tail index and analyzed the exchange rate volatility with extreme theory. maximize the returns. According to Jack Glen and Philippe Jorion (1993), the forward contracts' inclusion as a way to hedge against the currency risk has statistically significantly improved the performance of portfolios. In this thesis, hedging also is taken into consideration. So, suppose a joint portfolio, and suppose this investor has a downside risk constraint on his investment decision. Roy (1952) called them SF investors. They try to minimize the probability of disaster occurring. Arzac and Bawa (1977) applied the SF principle and supposed the investors approximate the tail of the portfolio's distribution. In this paper, suppose the investor holds an international portfolio with hedging, and want to check the portfolios' performance during the Asian Crisis and Financial Crisis under SF framework, and compared them to the portfolios' performance under MV framework.

When look at the statistical characteristic of equities' return, the return turns out to be excess kurtosis, showed a fat-tail distribution. Arzac and Bawa(1977) use Chebyshev bound to estimate the returns' distribution. In Jansen and Koedijk's work, they use extreme value theory to estimate the fat-tail distribution. This thesis is to continue Jansen's (1991，2000，2007) work, use extreme value theory to calculate the probability of extreme events.

As an exercise, suppose there is an American investor, who manages a portfolio comprising U.S equity and one of the three selected Asian countries. Allow the investor to hedge and invest in a proportion in a foreign equity and US equity, and then to try to

pick the best combination of the hedging ration and proportion ratio under both SF and MV framework.

The outline of the thesis is as follows: Chapter II introduces the portfolio selection theories we used in this thesis, they are currency hedging theory, MV theory and SF theory. Chapter III introduces the extreme value theory to estimate the parameters of the return which are fat-tail distribution and borrow the Hill Estimator to support the research. Chapter IV brings SF Theory and MV Theory into application. Chapter V gets the optimal combination of investment weights and hedging ratio, to calculate the portfolio's return, check the summary statistical characteristic of the investment sample, and compare performance by MV portfolio and SF portfolio. Conclusions and analysis are given immediately after the result. In Chapter VI is the data source.

# CHAPTER II

# PORTFOLIO SELECTION THEORIES

## Hedging Theory

During the last decade, U.S. investor began to invest in foreign securities. They faced multivariate risks not only limited to domestic market risk and system risk. One source of the risk coming from international investment is the foreign exchange risk.

Generally speaking, the aim of hedging is to eliminate the risk of future commitment of some asset. Just as mentioned in the Introduction section, as the development of international investment, the investors naturally face the problem whether to hedge against the risk of currency devaluation. For example, a hedge fund that decides to invest in a company in Indonesian, but does not like to invest in Indonesian rupiah, they can hedge the currency, and separate out the currency risk.

In Charles, Ronald and Herman's (2000) paper, they pointed out that the exchange rate is the economic variable that used as hedging instruments, particularly they use the forward exchange rate, and by covered interest rate parity, the ratio of forward exchange rate to spot exchange rate can be approximated by the difference of domestic and foreign

short-term interest rate. The investor borrows dollars to buy foreign currency, and simultaneously, in case the currency will appreciate, the investor buys a forward contract to sell the foreign currency at a fixed rate. And get dollars. The return from the hedging should be equal to the return from borrow dollars and invest in an interest-bearing instruments in the foreign currency.

$$\frac{F}{S} = \frac{1 + i_d}{1 + i_f}$$

where

F is the forward exchange rate

S is the spot exchange rate

$i_d$ is the domestic interest rate

$i_f$ is the foreign interest rate

## Mean Variance Theory

MV theory was developed in the 50's and 60's by Markowitz (1952), Tobin, Sharp (1964) and Lintner (1965) MV is still an important model to analyze investments decisions. It provides a treatment of the tradeoff between the returns and risk. This theory is built on a normal distribution, and it's a symmetric measure of the risk and variance. The investor is assumed to be indifferent to a high probability of negative outcome.

In the present thesis, suppose there are no transaction cost and no liquidity constraints. Make the assumption that there is only single-period investment, at the beginning, the investor is supposed to invest in one risky foreign equity, one risky domestic equity and one safe domestic asset. Suppose the risk-free rate is 3 month U.S. Treasury Bill rate. The return on the portfolio is a weighed sum of random variables. The weights can be decided by the investors.

At the beginning of the period:

$P_{j,t}$: Market prices of asset j in local currency term

$Q_{j,t}$: Quantity invested in asset j

$S_{j,t}$: The spot exchange rate in the reference currency (e.g. USD per Korean Won).

$W_t$: Initial wealth

$\mu_t$: Expected wealth at the end of period

$h_j$: Hedge ratio of the foreign asset

$w_{j,t}$: Proportion invested in asset j

$R_{t+1}$: Return of the portfolio at the period of t+1

Initial Wealth:

$$\sum_j Q_{j,t}P_{j,t}S_{j,t} = W_t + b_t \quad (1)$$

Considering hedging:

$$\mu_t = E_t\left\{\sum_j Q_{j,t}P_{j,t+1}S_{j,t+1} - \sum_j Q_{j,t}h_jP_{j,t}\left(S_{j,t+1} - F_{j,t}\right) - B_tR_{t+1}^f\right\} \quad (2)$$

$$R_{t+1} = \left(\frac{\sum_j Q_{j,t}P_{j,t+1}S_{j,t+1} - \sum_j Q_{j,t}h_jP_{j,t}\left(S_{j,t+1} - F_{j,t}\right)}{\sum_j Q_{j,t}P_{j,t}S_j}\right) \quad (3)$$

or

$$R_{t+1} = \sum_j w_{j,t}R_{j,t+1}^P R_{j,t+1}^s - \sum_j w_{j,t}h_{j,t}R_{j,t+1}^s + \sum_j w_{j,t}h_{j,t}(F_{j,t}/S_{j,t}) \quad (4)$$

Estimating the Variance

$$
\begin{aligned}
\mathrm{Var}\left(R_{t+1}\right) &= w_{1t}^2 \mathrm{Var}\left(R_{t+1}^f R_{t+1}^s\right) + w_{2t}^2 \mathrm{Var}\left(R_{t+1}^{US}\right) \\
&+ w_{1t}^2 h_{1t}^2 \left[\mathrm{Var}\left(\frac{1+i_t^{us}}{1+i_t^F}\right) + \mathrm{Var}(R_{t+1}^s)\right. \\
&\left. - 2\mathrm{cov}(R_{t+1}^s, \frac{1+i_t^{us}}{1+i_t^F})\right] \\
&+ 2w_{1t} w_{2t} \mathrm{cov}\left(R_{t+1}^f R_{t+1}^s, R_{t+1}^{US}\right) \\
&+ 2w_{1t}^2 h_{1t} \left[\mathrm{cov}\left(R_t^f, R_{t+1}^s, \frac{1+i_t^{us}}{1+i_t^F}\right)\right. \\
&\left. - \mathrm{cov}\left(R_{t+1}^f R_{t+1}^s, R_{t+1}^s\right)\right] \\
&+ 2w_{1t} w_{2t} h_{1t} \left[\mathrm{cov}\left(R_{t+1}^{us}, \frac{1+i_t^{us}}{1+i_t^F}\right) - \mathrm{cov}(R_{t+1}^{us}, R_{t+1}^s)\right]
\end{aligned} \tag{5}
$$

where

$R_t^f$: The local currency returns on foreign equity

$R_t^{us}$: The return on U.S equity

In consideration of the interest rate parity is certain, all the covariance and variance related to it will be zero, so the variance of portfolio is:

$$
\begin{aligned}
\mathrm{Var}\left(R_{t+1}\right) &= w_{1t}^2 \mathrm{Var}\left(R_{t+1}^f R_{t+1}^s\right) + w_{2t}^2 \mathrm{Var}\left(R_{t+1}^{US}\right) + w_{1t}^2 h_{1t}^2 [\mathrm{Var}(R_{t+1}^s)] \\
&+ 2w_{1t} w_{2t} \mathrm{cov}\left(R_{t+1}^f R_{t+1}^s, R_{t+1}^{US}\right) - 2w_{1t}^2 h_{1t} \left[\mathrm{cov}\left(R_{t+1}^f R_{t+1}^s, R_{t+1}^s\right)\right] \\
&- 2w_{1t} w_{2t} h_{1t} [\mathrm{cov}(R_{t+1}^{us}, R_{t+1}^s)]
\end{aligned}
$$

The Sharpe ratio:

$$
S = \frac{E[R(w_1, w_2, h_1)] - \text{risk free rate}}{\mathrm{STD}[R(w_1, w_2, h_1)]} = f(w_1, w_2, h_1)
$$

The ratio indicates the expected differential return per unit of risk associated with the differential return. By picking the largest value of Sharpe Ratio, we can get the optimal combinations of hedging ratio and proportions invested in foreign equity.

Consider about borrowing, suppose the investor will allocate his investment between the risky portfolio and the risk free asset, and suppose y is the proportion that the investor will invest in the risky proportion. The MV investor will maximize his utility level by choosing the best allocation to the risky portfolio. Then take reference to Bodie, Kane and Marcus's work in Investment 3rd edition(1996), the optimal proportion $y^* = \left( (E(R_{t+1}) - r_f) \Big/ A * Var(R_{t+1}) \right)$. A is the coefficient of risk aversion.

## Safety First Theory

Analyze the same problem under SF framework. SF theory also supplies a tradeoff between risk and return but with the consideration of the limited downside risk. Roy (1952) states that the best portfolio is the one has the smallest probability of producing a return below some specified level. We also make the assumption that there is only a single-period investment, at the beginning, the investor is supposed to invest in one risky foreign equity, one risky domestic equity and one safe domestic asset. Allow the investor borrow or lend the safe domestic asset at risk-free rate. But there is no short position under this framework.

Consider the investment selection with SF constraint, namely, the downside-risk constraint. Take the constraints into consideration by maximizing the expected portfolio's return subject to it.

At the beginning of the period:

$P_{j,t}$: Market prices of asset j in local currency term

$S_{j,t}$: The spot exchange rate in the reference currency (e.g. USD per Korean Won)

$W_t$: Initial wealth

$B_t$: Borrowing amount (A negative value indicates lending)

$R_t^{rf}$: Risk free gross rate of return, known at time t

Initial Wealth:

$$\sum_{j} Q_{j,t} P_{j,t} S_{j,t} = W_t + b_t \tag{7}$$

Considering hedging:

$$\mu_t = E_t \left\{ \sum_{j} Q_{j,t} P_{j,t+1} S_{j,t+1} - \sum_{j} Q_{j,t} h_j P_{j,t} \left( S_{j,t+1} - F_{j,t} \right) - b_t R_t^{rf} \right\} \tag{8}$$

$F_{j,t}$: is the forward foreign exchange rate in dollars per unit of country, j foreign currency rate at t. The forward rate is known at time t, and future spot rate is uncertain.

The first summation on the right hand side is the risky assets value including both domestic and foreign denominated with U.S. Dollar at time t+1. The second summation is the value of hedging transactions. A U.S. investor hedges some portion of a foreign currency-denominated equity position by shorting the foreign currency and lending U.S. dollars. The last term on the r.h.s of the equation is the amount of money the investor has to payback for the loan at the risk free rate.

The SF downside constraint condition is given below at given disaster level and probabilities.

$$\text{Probability} \left\{ \sum_j Q_{j,t} P_{j,t+1} S_{j,t+1} - \sum_j Q_{j,t} h_j P_{j,t} \left( S_{j,t+1} - F_{j,t} \right) - b_t R_t^{rf} \leq s \right\} \leq \delta \tag{9}$$

s: the disaster level of wealth.

δ: maximal acceptable probability of the disaster.

The gross return of risky assets on this portfolio is calculated as:

$$R_{t+1} = \left( \frac{\sum_j Q_{j,t} P_{j,t+1} S_{j,t+1} - \sum_j Q_{j,t} h_j P_{j,t} \left( S_{j,t+1} - F_{j,t} \right)}{\sum_j Q_{j,t} P_{j,t} S_j} \right) \quad (10)$$

or

$$R_{t+1} = \sum_j g_{j,t} R^P_{j,t+1} R^s_{j,t+1} - \sum_j g_{j,t} h_{j,t} R^s_{j,t+1} - \sum_j g_{j,t} h_{j,t} (F_{j,t}/S_{j,t}) \quad (11)$$

g: is the proportion of the asset j in total portfolio value.

h: is the hedging proportion in

$$\text{probability}\left( R_{t+1} \le R^{rf}_t + \frac{W_t R^{min} - W_t R^{rf}_t}{W_t + b_t} \right) \le \delta \quad (12)$$

$R^{min}$ is obtained when the wealth is s, which indicates at the disaster level.

Then we calculate the quantile value $q^{(R)}_\delta$ such that there is a $\delta$ percent chance of returns less than or equal to this value. So:

$$\text{probability}\left( R_{t+1} \le q^{(R)}_\delta \right) = \delta \quad (13)$$

Then the SF criterion is violated whenever

$$q^{(R)}_\delta < R^{rf}_t + \frac{W_t R^{min} - W_t R^{rf}_t}{W_t + b_t} \quad (14)$$

The quantile $q^{(R)}_\delta$ is just the value at risk.

$$W_t + b_t = \frac{W_t R^{min} - W_t R_t^{rf}}{q_\delta^{(R)} - R_t^{rf}} \quad (15)$$

If some favorable risks are available, the portfolio problem can be rewritten as:

$$\max_{g_j, h_j, b} \mu = W_t R_t^{rf} + \left(W_t R^{min} - W_t R_t^{rf}\right) E_t(R_{t+1} - R_t^{rf}) / (R_t^{rf} - q_\delta^{(R)}) \quad (16)$$

Because $W_t R_t^{rf}$, $W_t R^{min} - W_t R_t^{rf}$ are already given, so the problem is reduced to maximize the ratio of risk premium to the return opportunity loss with probability $\delta$.

$$\max_{g_j, h_j} \frac{E_t(R_{t+1} - R_t^{rf})}{(R_t^{rf} - q_\delta^{(R)})} \quad (17)$$

# CHAPTER III

## EXTREME VALUE THEORY

According to equation (17), we should determine the value at risk, given the risk level $\delta$ , the value can be determined by the portfolio's distribution. As mentioned earlier in Chapter I, Bawa and Arzac have made a normal distribution assumption. However, after test the statistical characteristic of the portfolio return. The return shows a fat-tail distribution and negative skewness. So continue with the SF framework, it's better to focus on the parameters describing the lower tail behavior. The research base on previous work done to estimate the tail distribution, for example, Bruce M.Hill(1975) based his method on an evaluation of the conditional likelihood for parameters describing the tail behavior, given the values of the extreme order statistics. And the extreme value theory studies the limit distribution of the order statistics. The tail index is a good indicator for the mass in the tails. It offered the information about the underlying distribution. de Haan, Jansen, Koedijk and Vries(1994) has tested and claimed that the extreme value theory showed a better bound than the chebyshev bound.

Follow Vries'(1994) work: Let $X_1, X_2 \dots X_n$be a sequence of mutually independent random variables with distribution function $F(*)$. let $X_1, X_2 \dots X_n$ be in descending order, thus $X_1 > X_2 > \dots > X_n$, the probability of the first n random variables that below a certain value S is given by $P(M_n < s) = F^n(x)$, where $M_n = Max(X_1, X_2 \dots X_n)$. For an enlarging sample size, the normalized distribution will converge to a limiting distribution G(x), By the theory of GEV (Generalized extreme value) distribution, there are three types, known as type I,II and III extreme value distribution. The GEV

distribution is the limit distribution of properly normalized maxima of a sequence of i.i.d distributed random variables.

$$\text{Type I}: \mathrm{G(x)} = \exp(-\mathrm{e}^{-\mathrm{x}}) \quad -\infty < x < \infty$$

$$\text{Type II: } \mathrm{G(x)}=0 \qquad x \ll 0,$$

$$\mathrm{G(x)} = \exp(-\mathrm{x}^{-\alpha}) \qquad x > 0$$

$$\text{Type III}: \mathrm{G(x)} = \exp(-(-\mathrm{x})^{-\alpha}) \quad x < 0$$

$$= 1 \qquad x > 0$$

The index α is called the tail index which is the index of declining rate in the tail of the distribution. According to the analysis of Jansen and Vries (1994), the limiting distribution G(x) is one the three asymptotic distributions. Check the stock returns' statistical characteristic which is fat-tailed and is characterized by a lack of some higher moments. So we adopt type II distribution. Because type I includes all the moments, and type III has a finite upper endpoint, however type II lacks higher moments and is bounded.

Suppose there are nonnegative normalizing constants $a_n, b_n$. Such that

$$F^n(\frac{x}{a_n} + b_n) \xrightarrow{w} G(x),$$

A non-degenerate d.f G is called max stable if there exist real constants $A_n > 0, B_n$ such that for all real x and natural number n

$$G^n(A_n x + B_n) = G(x)$$

the sufficient condition for $\mathrm{F^n(x)}$ to be in the domain of attraction is it has no finite upper endpoint, and for positive x.

$$\lim_{n\to\infty}\frac{1-F(nx)}{1-F(x)}=x^{-\alpha}$$

It's a regularly varying function. The number is not 1.

Use Hill estimator to calculate α,

The Hill Estimator is:

$$\hat{\beta}=\frac{1}{\alpha}=\frac{1}{\mathrm{k}}\sum_{\mathrm{i}=1}^{\mathrm{k}}[\log(\mathrm{X}_{\mathrm{n}+1-\mathrm{i}}/\mathrm{X}_{\mathrm{n}-\mathrm{k}})] \tag{18}$$

where k is the number of the upper $\mathrm{k}^{\mathrm{th}}$ elements used to calculate the tail index.

Mason(1982) shows $\hat{\beta}$ is consistent for the tail index under the regular variation condition and the return series are i.i.d. And Goldie and Smith (1987) shows that $\widehat{(\beta}-\beta)\mathrm{k}^{1/2}$ is asymptotically normal with 0 mean and variance.

Next step is to calculate the order statistic k, the choice of k should be that the k goes to infinity with the increasing of n, but k/n should be finite. Be consistent with Jansen's (2008) work; use the methods that brought up by Drees and Kaufmann (1998), they point out the $\hat{\beta}$ is greatly depend on the choice of the k, a large k will lead to a large bias, while the variance will be large if select a small k. in their paper, they design a method to calculate the optimal number $\widehat{k_{opt}}$based on "stopping time" $k_n(r_n)$, which are the threshold of k based on the asymptotic properties of $\hat{\beta}$, and they obtain a consistent estimator of $k_{opt}$ in the sense that $\widehat{k_{opt}}/k_{opt}\xrightarrow{p}1$, and $\hat{\beta}_{n,\hat{k}_n^{opt}}$ has the same asymptotic efficiency as $\hat{\beta}_{n,k_n^{opt}}$.

And then, estimate the quantile $q_p$, to calculate the values at risk when the probability p less than the order of 1/n. Based on a corollary to Dekkers et al. (1989) derived in the appendix of de Haan et al.(1994) :

$$\hat{q}_p = X_{(n-k)} \left(\frac{k}{pn}\right)^{1/\alpha} \tag{19}$$

where

n: the sample size

k: the maximum k of sample

p: the probability of disaster level

α: the tail index

# CHAPTER IV

# APPLICATION

## Safety First Application

Suppose a hypothetical American Investor invests in a portfolio including U.S equity and one of the Asian Countries.

The sample size starts from the beginning of each country's data selection and ends on Jun 03 2010, the sample range is denoted as 1 to n. Select the day prior to the Asian Crisis as the start date of the crisis. Suppose the expected return on spot exchange equals the ratio of forward to spot price.

The parameters selection for SF theory's application takes reference of Jansen's (2008) work. The probability of the bad portfolio performance is set to be once in ten years. $\delta$ is set to be 1/520. $R^{min}$ is set to be 0.8. Thus the SF investor wants a 1/520 chance of a 20% decline in his portfolio. The results are robust to the specification of a disaster, such as setting $R^{min}$=0.9, with results shown at the end of this thesis. The Value at risk is estimated at different combinations of hedging ratio (h) and equity weights (w). And estimated returns will be given at the different combinations of hedging and equity weight, then the optimal combination of h and w will be found by checking the highest critical value, and the optimal portfolio return and borrowing level can be calculated. And we use the optimal h and w to calculate the real return. The Gauss code is given in Appendix B.

## Mean Variance Application

Under MV framework, it's assumed that the portfolio return complies with the Normal distribution assumption. The sample data is the same ones as used in SF application. Assume that the investor just hedge against risk, not speculate, so make the interest rate parity equals the ratio of forward rate to spot exchange rate, so formula (4) is simplified to the first two part, namely, the sum of dollar return on foreign equity and U.S equity. Here, both the mean and the variance of the return are calculated by 30 weeks moving average using convolution method, then the Sharpe ratio is obtained by dividing the mean by the corresponding variance at the combination of hedging ratio and equity weights. The optimal combination of h and w can be picked up directly by observing the highest Sharpe ratio. The MatLab code is given in Appendix A.

# CHAPTER V

# RESULTS

Table 1: Summary Statistics: Entire Sample

| Local Currency Returns on Equity Continuous Compounding | | | | | | |
|---|---|---|---|---|---|---|
| | Mean | Std.Dev. | Kurtosis | Min | Max | Size |
| Indonesia | 0.0018235 | 0.0392041 | 3.891993042 | -0.235545 | 0.177260226 | 1019 |
| South Korea | 0.0015409 | 0.04304234 | 3.562931258 | -0.22596 | 0.252315022 | 878 |
| Thailand | -0.000543 | 0.04632232 | 2.063102649 | -0.182295 | 0.206152996 | 726 |
| US | 0.0013837 | 0.02425849 | 12.12956552 | -0.202878 | 0.167955025 | 1019 |
| Spot Ex. Rate Returns (US $ per unit local currency)Continuous Compounding | | | | | | |
| Indonesia | -0.001557 | 0.03751334 | 99.56528459 | -0.637577 | 0.217412877 | 1019 |
| South Korea | -0.000456 | 0.02532455 | 81.77256151 | -0.334713 | 0.328119595 | 878 |
| Thailand | -0.000343 | 0.01420857 | 24.79964616 | -0.115559 | 0.10831384 | 726 |
| Dollar Returns on Equity, Continuous Compounding | | | | | | |
| Indonesia | 0.0002662 | 0.05899535 | 32.76436218 | -0.773537 | 0.324417896 | 1019 |
| South Korea | 0.0010792 | 0.05431987 | 15.74211837 | -0.522536 | 0.398837264 | 878 |
| Thailand | -0.000887 | 0.05087262 | 2.597733657 | -0.204397 | 0.285322546 | 726 |

*Indonesian sample begins from Nov.29. 1990 ends Jun.03. 2010; Korean sample begins from Aug. 12. 1993 ends Jun.03. 2010; Thai sample begins from Jul.04. 1996 ends Jun.03.2010

Table 1 shows the statistics of the data selected. Kurtosis shows volatility and offers the information on tail distribution. All three Asian countries show high kurtosis on spot exchange rate of return, which indicate extreme returns near the mean. The SF theory applied in this thesis just based on the extreme returns.

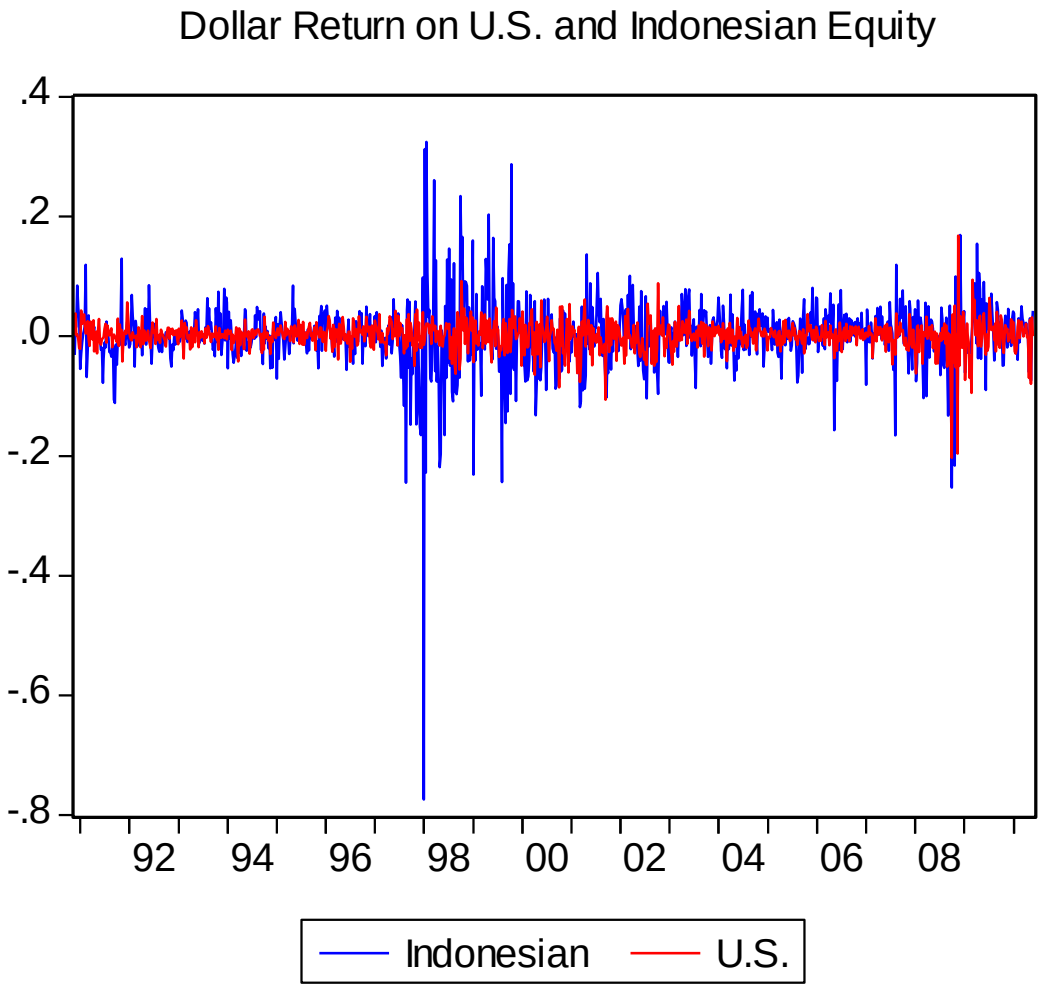


**Fig. 1. Dollar Return on U.S. and Indonesian Equity.**

Figure 1 shows the comparison between of the dollar return on Indonesian equity and the U.S. equity return. We can pick up two separate parts to look at from the entire sample, the first part starts in mid-1997, ends 2002, which is also the period of Asian-Crisis. It shows a great increase in the volatility of Indonesian equity. There is great fall dated on Jan. 8th 1998, it was 63.73% decrease compared to the previous week (Jan. 1st, 1998) on the spot exchange rate, and 13.60% decrease on local currency return on Indonesian equity. The 2nd part is the Financial Crisis starting in Aug. 2007 till the end. Both the Indonesian and U.S. equity show relatively large volatility because the increasing volatility of world stock market.. The mean of U.S equity is significantly higher than the mean of Indonesian equity. However, the Indonesian equity has a higher standard deviation.

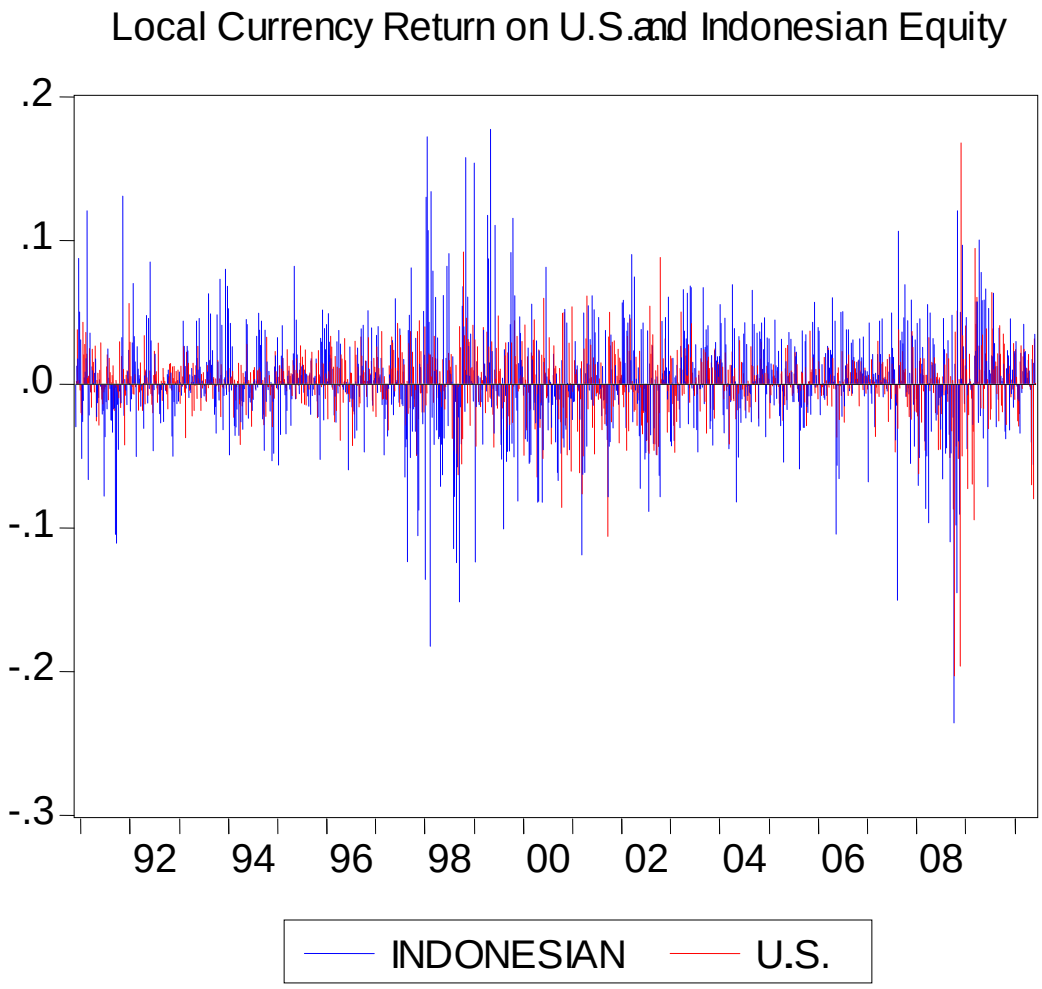


**Fig. 2. Local Currency Return on U.S.**

Figure 2 shows the local currency returns on Indonesian and U.S. equity. Over the entire sample, the Indonesian equity shows more volatility than U.S. equity, and the volatility has increased during the mid-1997, which is the beginning of the Asian Crisis. However, not like dollar return, Indonesian equity also shows a higher mean return than U.S. equity.

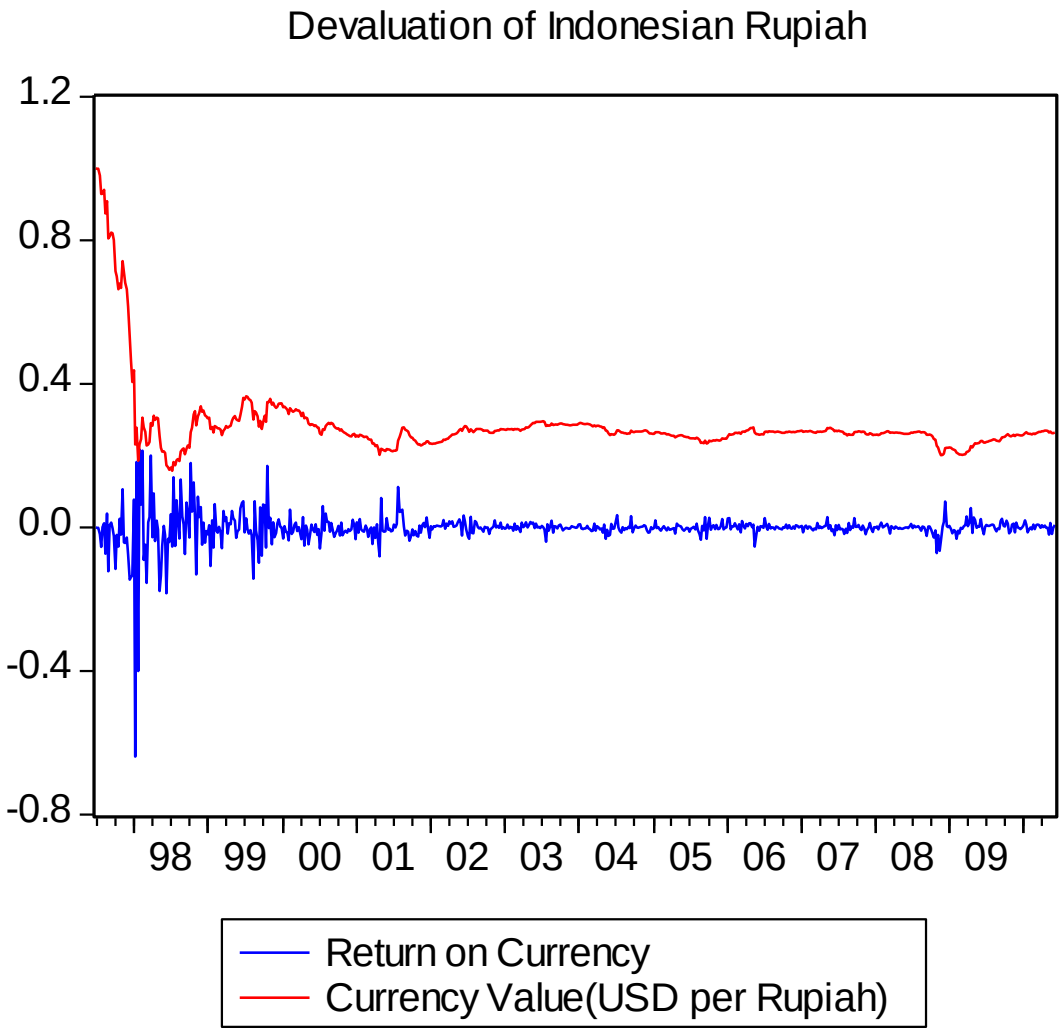


**Fig. 3. Devaluation of Indonesian Rupiah.**

Figure 3 shows the behavior of Indonesian spot exchange rate, it has a great depreciation of Indonesian Rupiah during Asian Crisis. There is no obvious volatility during financial crisis.

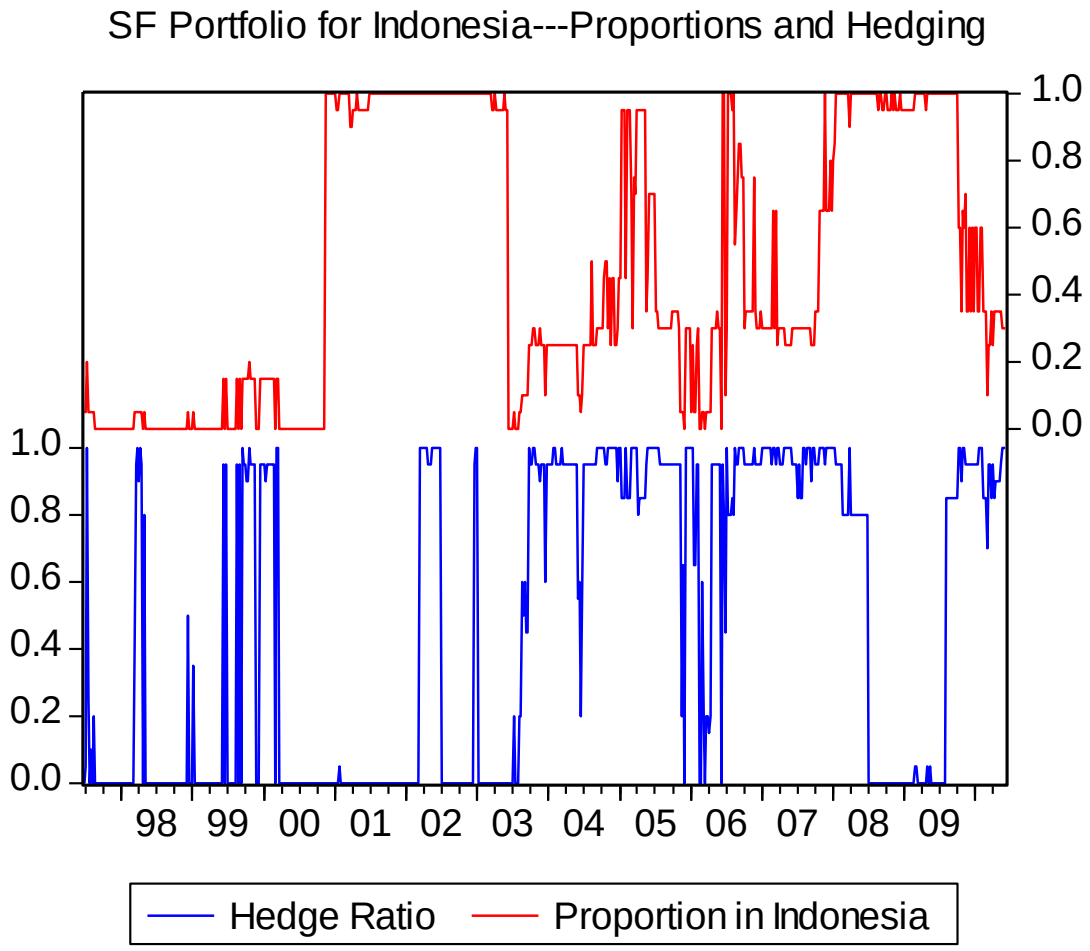


**Fig. 4. SF Portfolio for Indonesia---Proportions and Hedging.**

Figure 4 shows the optimal SF portfolio investment proportions and hedge ratios combinations. Till 2000, there is almost no investment on Indonesian equity, even when there is some investment proportions are heavily hedged. From 2000 to 2003, Indonesian equity is heavily invested but unhedged. Beginning 2003 till 2004 the investment proportion decreased to a low level and later increased and fluctuated a lot but with a higher hedge ratio until late 2007. And look at the period of Financial Crisis, during the

late 2007 till the beginning of 2009, Indonesian equity is heavily invested and almost no hegding. And at the end of the sample, the investment proportion decreased with increased hedging ratio.

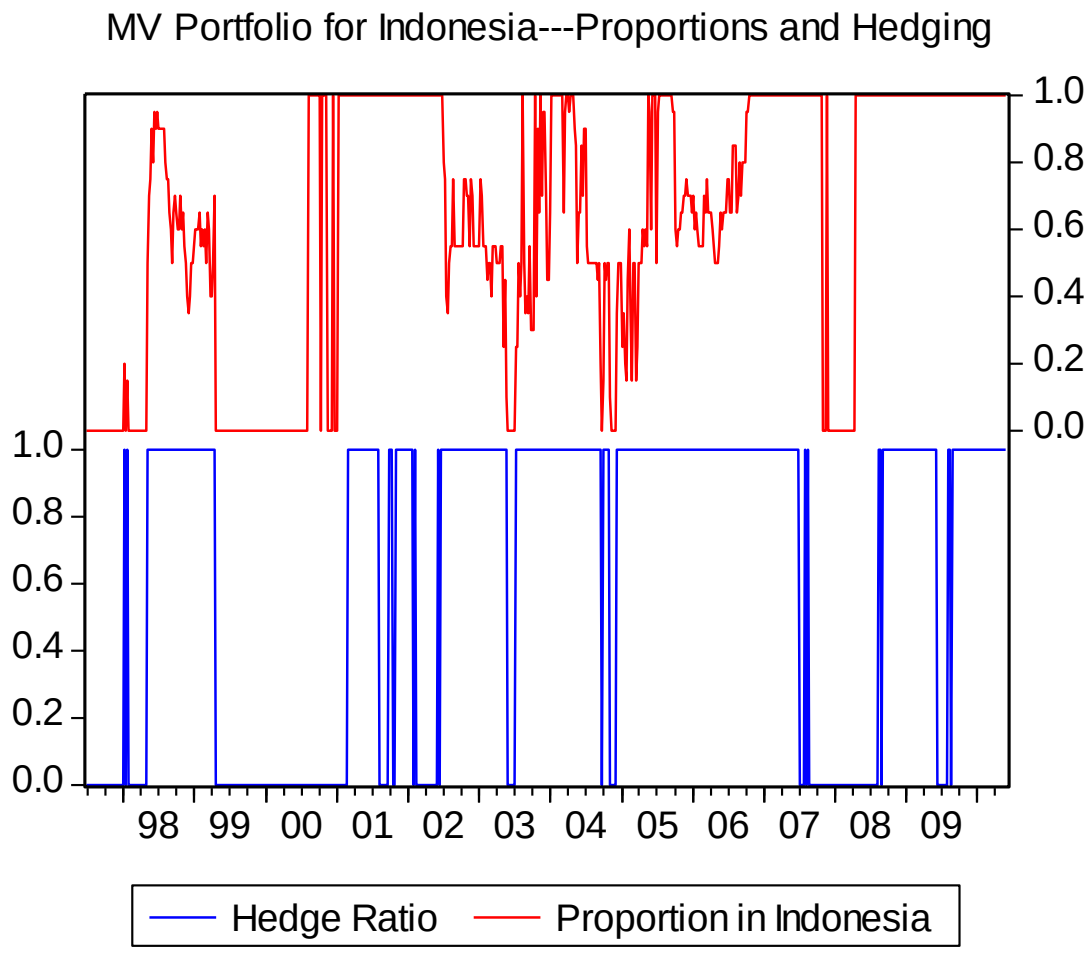


**Fig. 5. MV Portfolio for Indonesian---Proportions and Hedging.**

Figure 5 shows the optimal MV portfolio investment proportions and hedge ratios combinations. Different from SF portfolio, in 1998, the investment proportion in

Indonesia is high and with full hedging. During the financial crisis, full investment in Indonesia equity, and with high hedge ratio for most of the time.

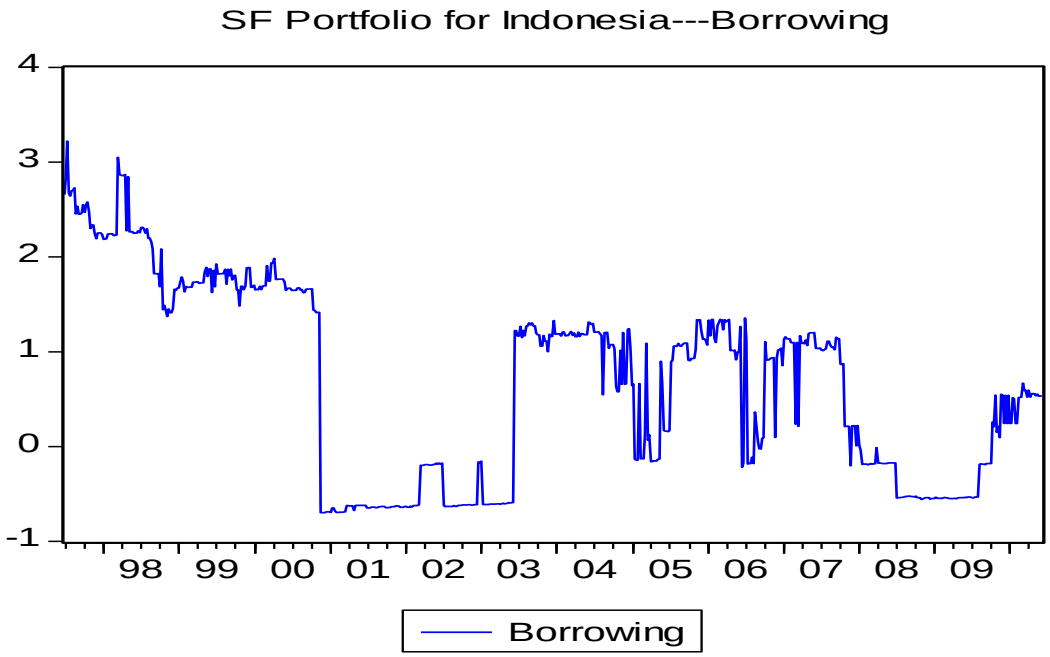


**Fig. 6. SF Portfolio for Indonesia---Borrowing.**


**Fig. 7. MV Portfolio for Indonesia---Borrowing.**

Figures 6 and 7 show the borrowing level for SF and MV portfolio. The two portfolios has different assumptions about the risk level, this is also reflected in borrowing level. For SF portfolio, the initial level begins around 3, but decrease below 0 in 2000 and stayed there until 2003. And during 2003 and 2007, the borrowing level stays around level 1, During the Financial Crisis, the borrowing level decreased to below 0 and increased to higher level at the end of the sample. For MV portfolio, the initial level is around 0 and after a short surge in early 1998; it decreases back to -1, and it has another peak in 2000, after that it fluctuate around level 0 and stay low from 2003 until late 2007, then fluctuate around level 0 during the financial crisis.

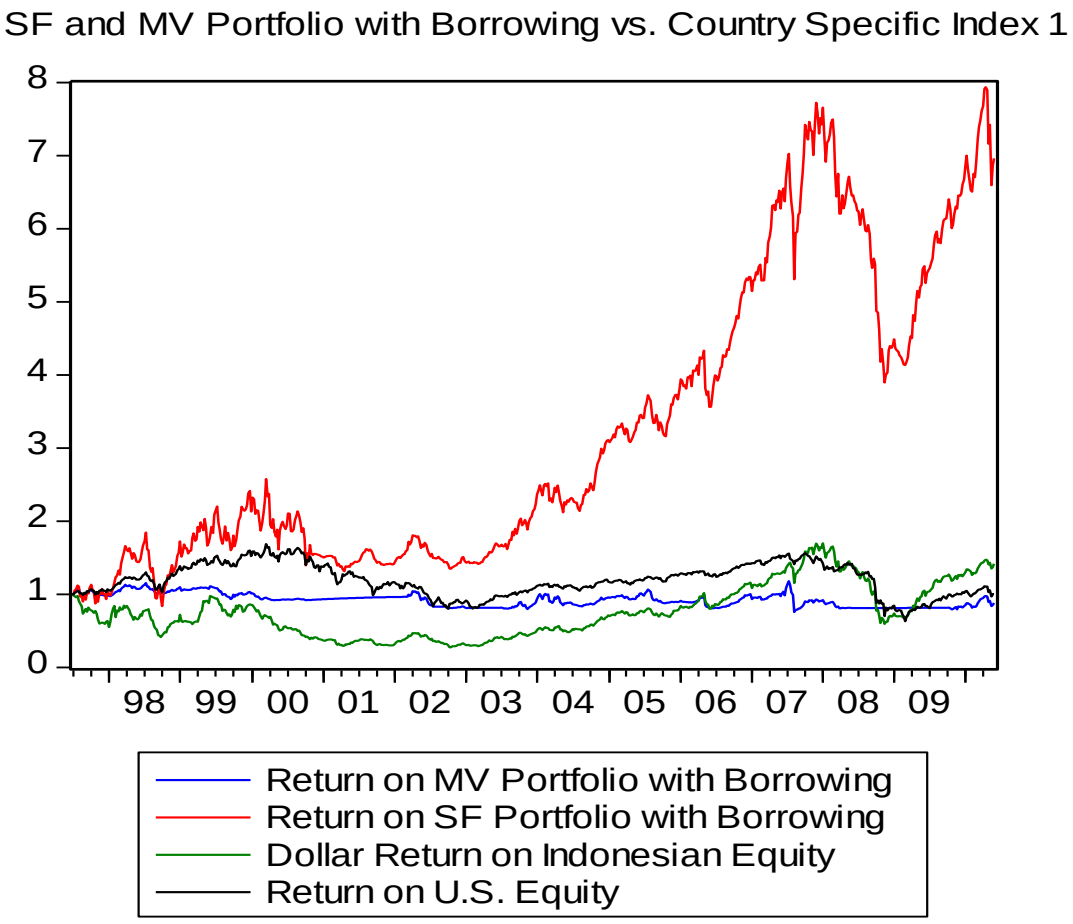


**Fig. 8. SF and MV Portfolio with Borrowing vs. Country Specific Index 1.**

Figure 8 shows the comparison among different investment portfolio with borrowing, also suppose the buy and hold strategy, namely the dollar return in 100% Indonesian equity, and 100% U.S. equity. If an investor just invest in the Indonesian will lose almost 72% of its initial value during the Asian crisis. Before the Financial Crisis, Indonesian equity showed an increasing trend, although it also suffers a sharp loss during the Financial Crisis, it recovers soon after that. For the U.S. equity, the Asian Crisis does not have a deep impact on it, however, situations getting worse in the Financial Crisis. At

the end of the sample, it falls to 68% of its initial wealth level. Now turn to the portfolio, the SF portfolio with borrowing outperformed the MV portfolio with borrowing, take preference of Table of the Risky Portfolio Returns. Look at the sub-periods, the SF portfolio outperformed MV portfolio during the Asian Crisis, the period after Asian Crisis, period after IT Bubble Bust, and period after Financial Crisis. Only during the IT Bubble Bust period and Financial Crisis, MV portfolio does better than SF portfolio. Generally speaking, looking at the whole period, the wealth level of SF portfolio is higher than the MV portfolio, particularly, the wealth level of the SF portfolio peaks in late 2007 and later suffered sharp decrease in Financial Crisis, however, at the end of the sample, the SF portfolio rise to the 700% of its initial wealth level, the MV wealth level rises to 84% of its initial wealth level. Holding the SF portfolio has the highest wealth at the end.

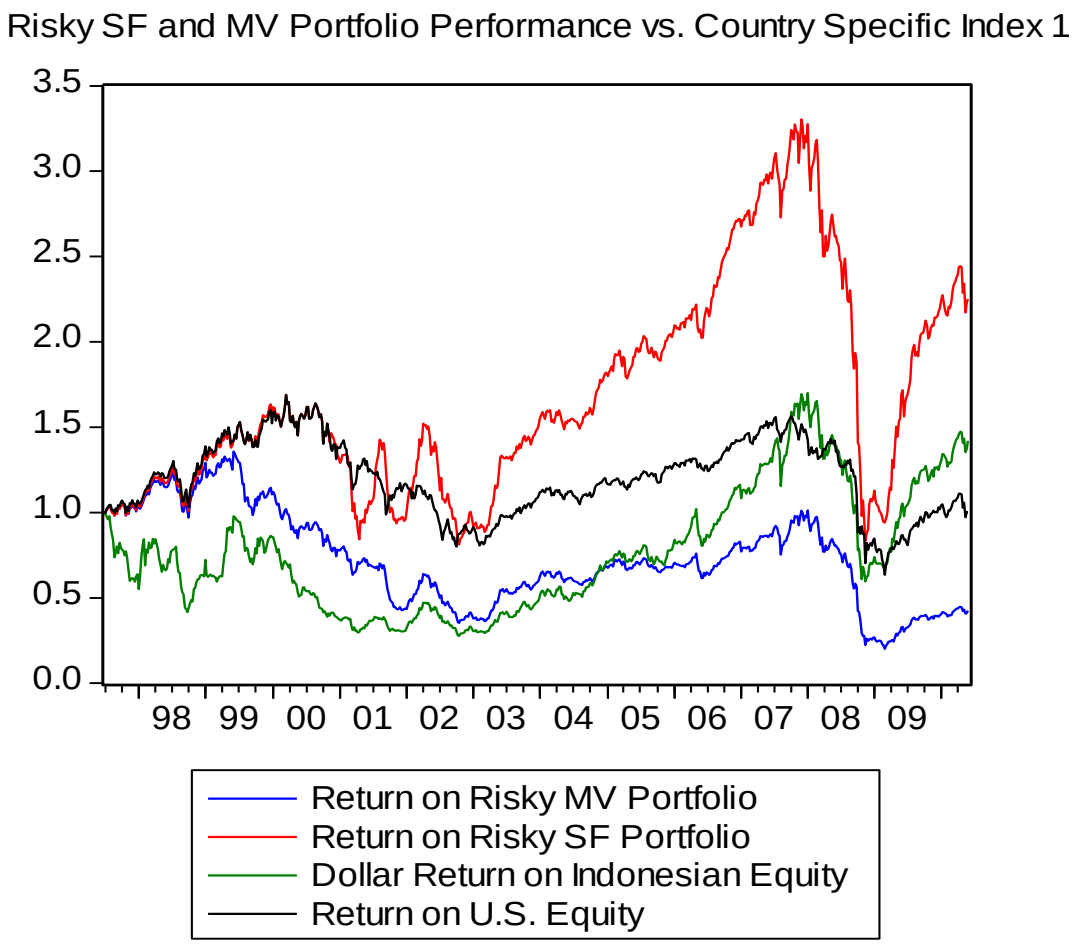


**Fig. 9. Risky SF and MV Portfolio Performance vs. Country Specific Index 1.**

Figure 9 shows the comparison among risky portfolio of SF and MV, also suppose the buy and hold strategy. From the graph we can observe that the performance of SF portfolio is far better than any other portfolios. MV portfolio barely better than Indonesian equity index at the first half of the sample period, however, in the long run, it is getting worse and the wealth level decreases to the 40% of the initial level at the end. From Table 3 we can get that SF also outperform MV portfolio for each sub-period.

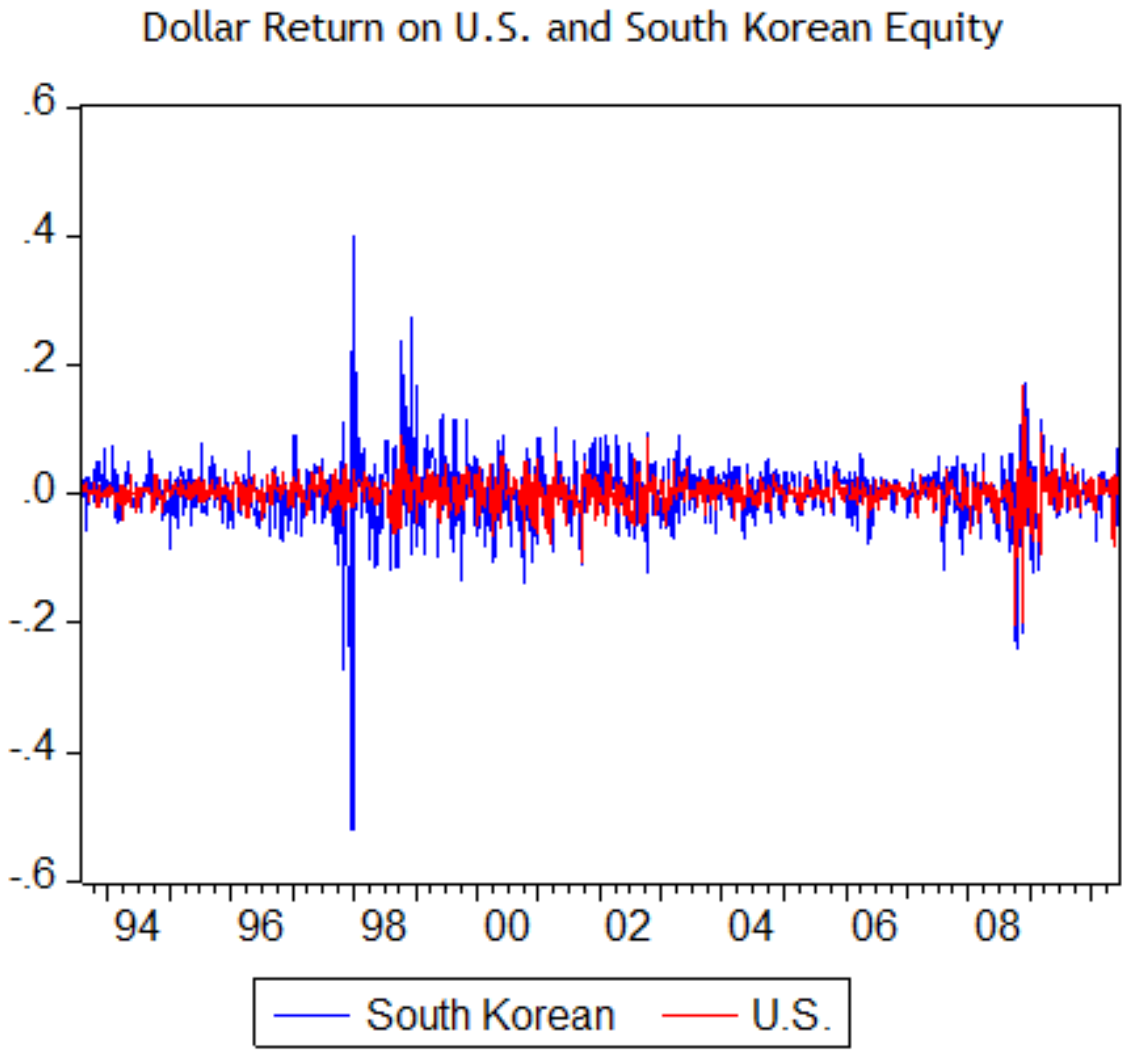


**Fig. 10. Dollar Return on U.S. and South Korean Equity.**

Figure 10 shows the comparison between of the dollar return on South Korean equity and the U.S. equity return. We can pick up two separate parts to look at from the entire sample, the first part starts in mid-1997, ends 2002, which is also the period of Asian-Crisis. It shows a great increase in the volatility of South Korean equity. There is a great fall dated on Dec. 25$^{th}$ 1997, it was 33.47% decrease compared to the previous week (Dec. 18$^{st}$, 1997) on the spot exchange rate, and 18.78% decrease on local currency return on Indonesian equity. The 2$^{nd}$ part is the Financial Crisis starting in Aug. 2007 till the end. Both the South Korean and U.S. equity show relatively large volatility because the increasing volatility of world stock market. There is no huge difference between the mean return of U.S equity and the mean return of South Korean equity. However, the South Korean equity has a higher standard deviation.

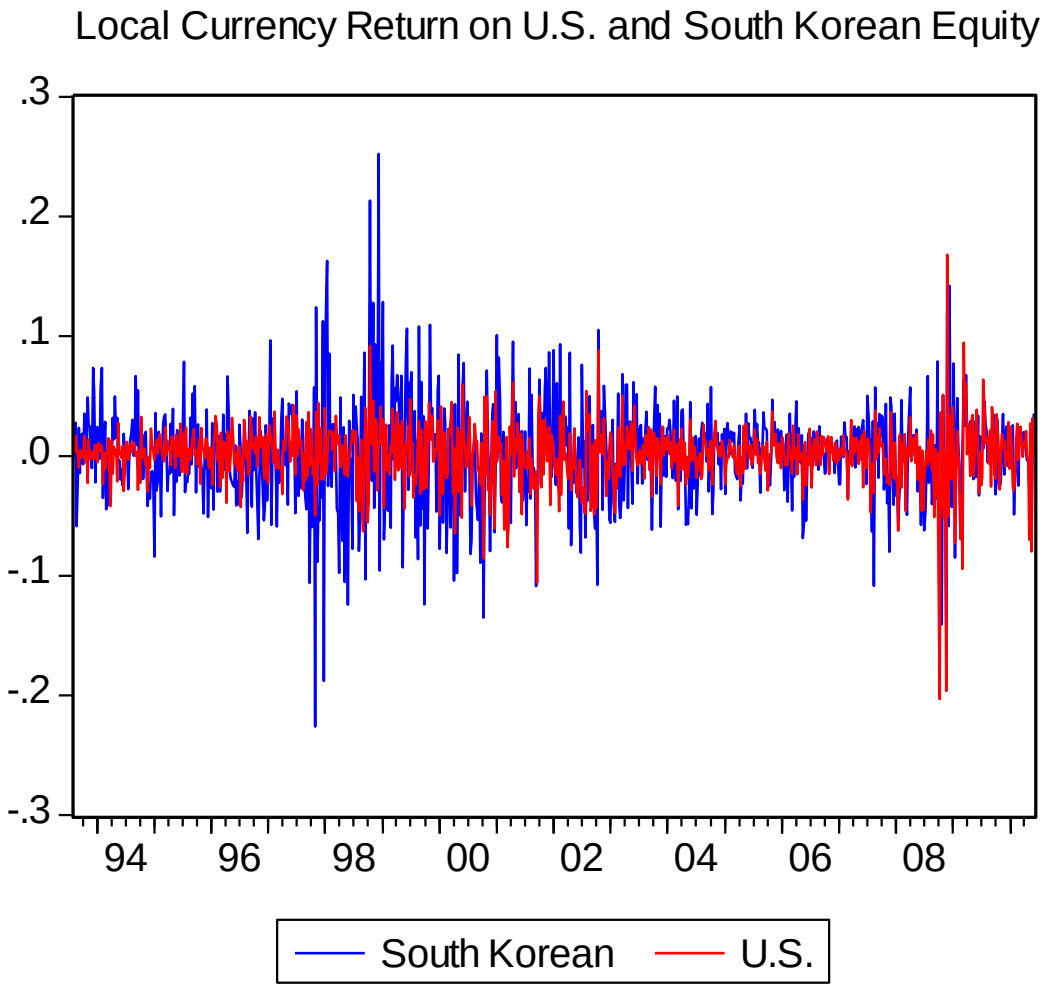


**Fig. 11. Local Currency Return on U.S. and South Korean Equity.**

Figure 11 shows the local currency returns on South Korean and U.S. equity. Over the Asian Crisis, the South Korean equity shows more volatility than U.S. equity, and the volatility of U.S. has increased during the Financial Crisis. However, it's not like dollar return, South Korean equity shows a higher mean return than U.S. equity.

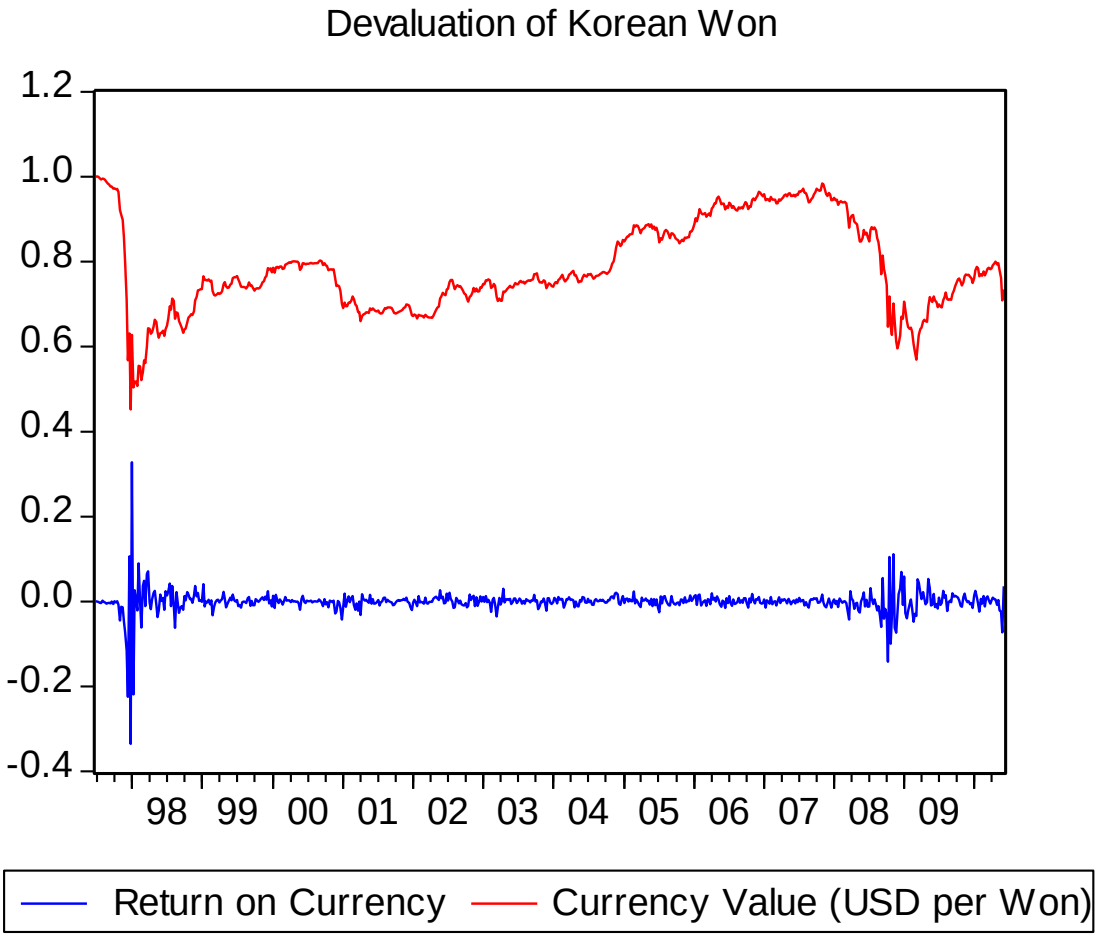


**Fig. 12. Devaluation of Korean Won.**

Figure 12 shows the behavior of South Korean spot exchange rate, it has a great depreciation of South Korean Won during Asian Crisis. And there is also obvious depreciation during financial crisis.

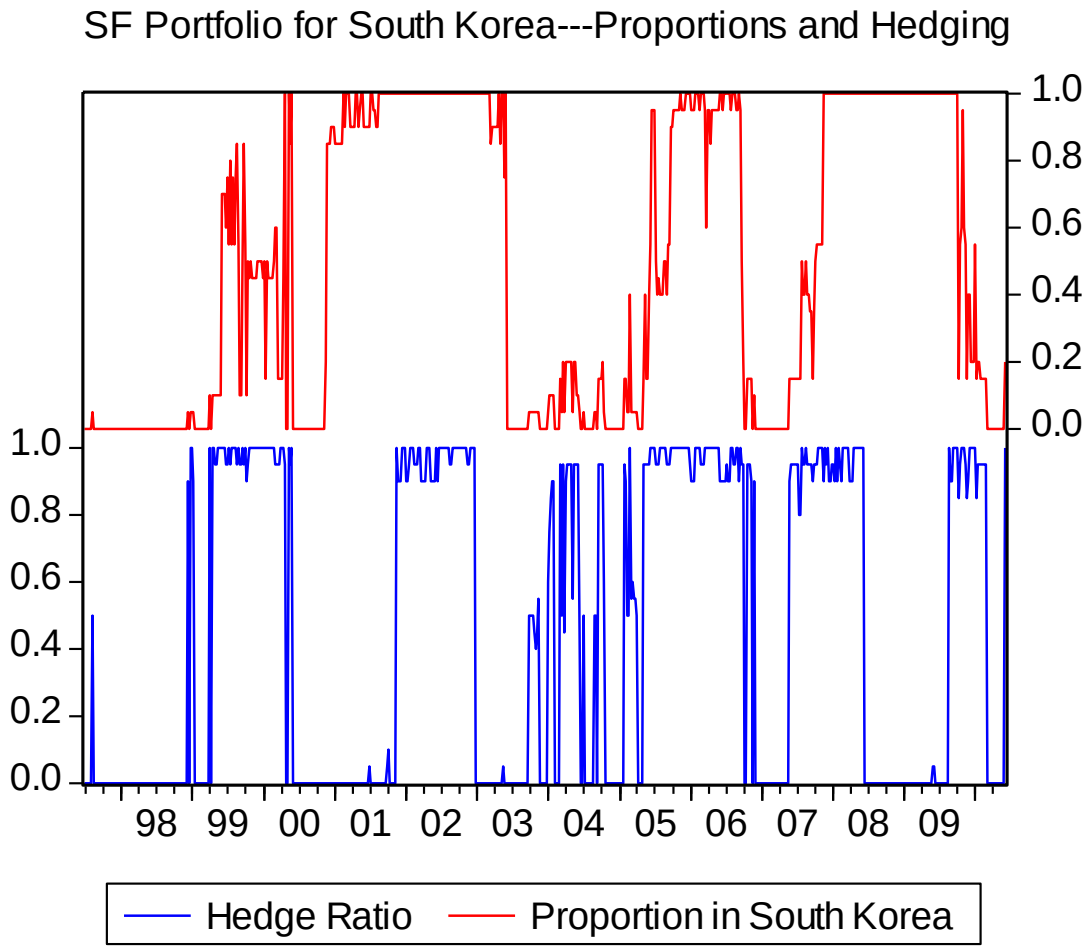


**Fig. 13. SF Portfolio for South Korea---Proportions and Hedging.**

Figure 13 shows the optimal SF portfolio investment proportions and hedge ratios combinations for South Korea. Till late 1998, there is almost no investment on South Korean equity, even when there is some investment proportions are heavily hedged. From 2000 to 2003, South Korean equity is heavily invested. Beginning 2003 till 2004 the investment proportion decreased to a low level with high hedging ratio. During 2004 to 2006, the portfolio invested a high proportion on South Korean equity and with a high

hedging ratio. And look at the period of Financial Crisis, during the late 2007 till the beginning of 2009, South Korean equity is heavily invested and almost no hedging. Borrowing level is showed in the below graph, the initial level begins around 3, but decrease below 0 in 1998, later increased to 2 and stayed there until 2000. And during 2000 and 2003, the borrowing level is low, During the Financial Crisis, the borrowing level decreased to below 0 and increased to higher level at the end of the sample.

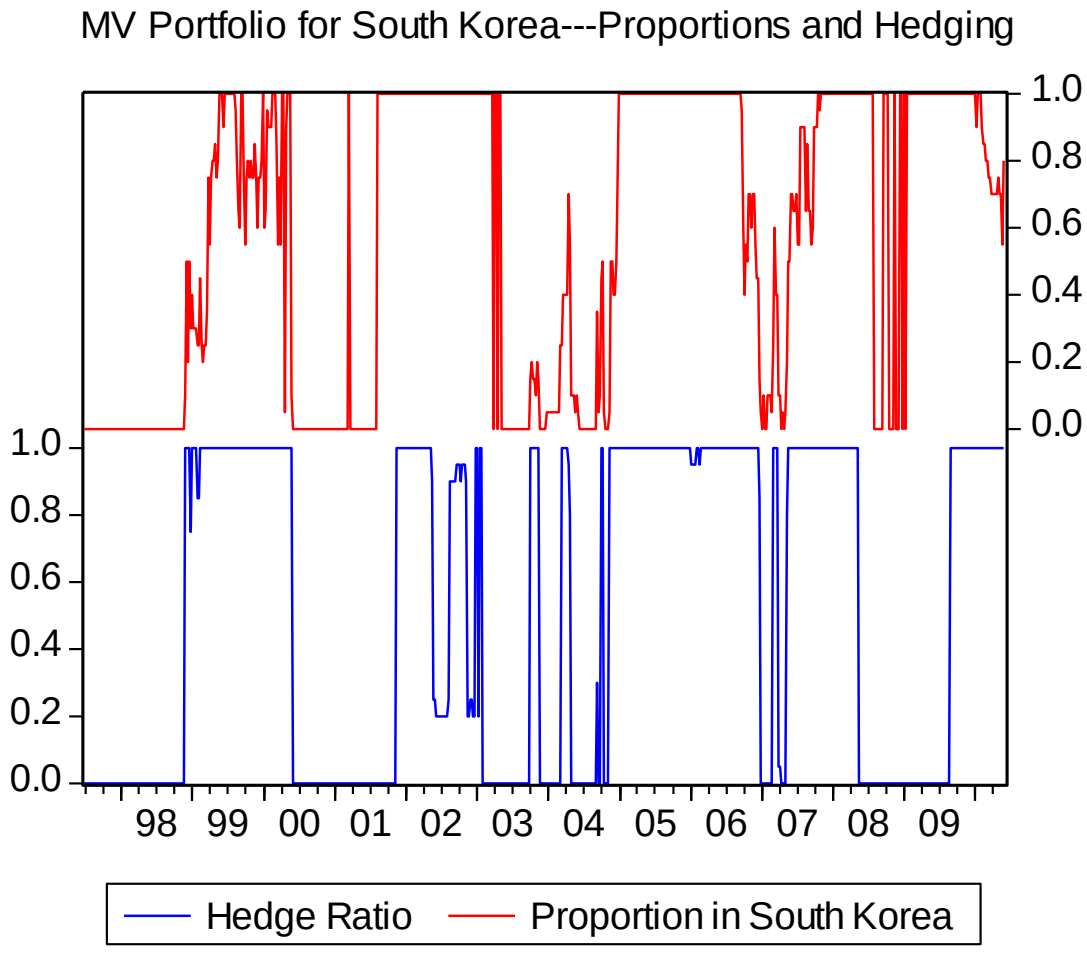


**Fig. 14 MV Portfolio for South Korea---Proportions and Hedging.**

Figure 14 shows the optimal MV portfolio investment proportions and hedge ratios combinations for South Korea. It has show a similar pattern for MV portfolio with SF portfolio. There are only some slight differences in details. Generally speaking, MV portfolio has reflected smoothness in its proportion and hedging combination.

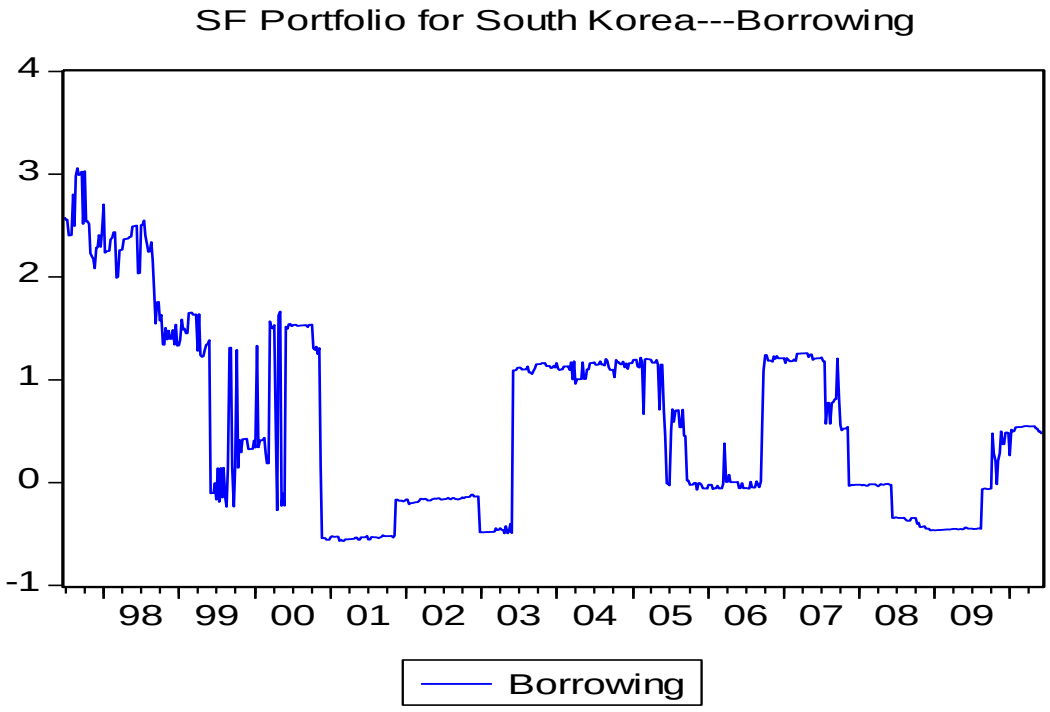


**Fig. 15. SF Portfolio for South Korea---Borrowing.**

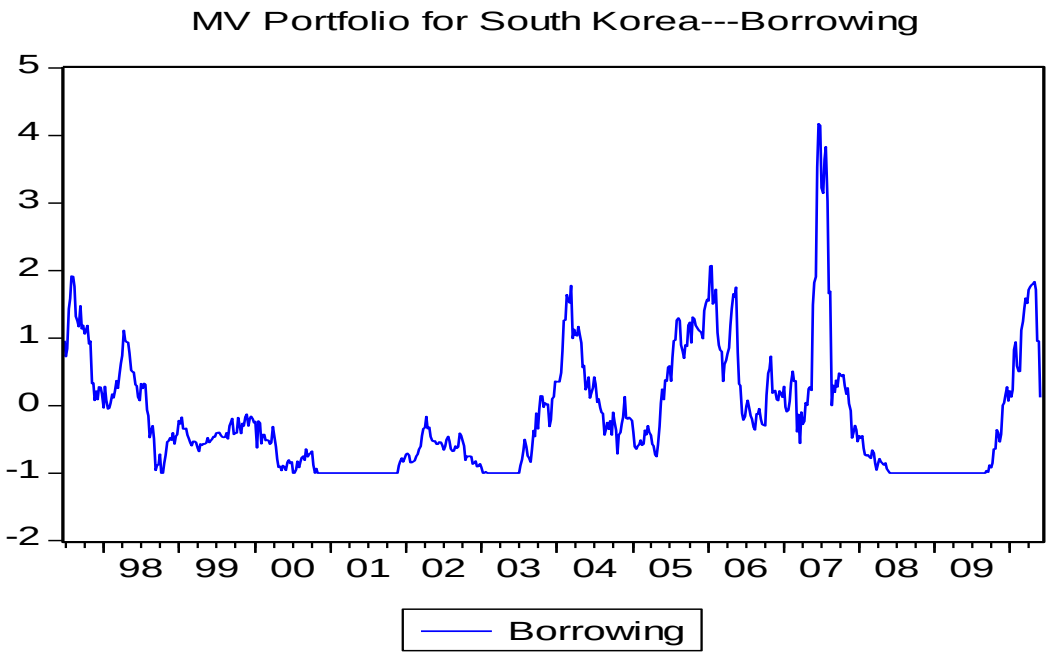


**Fig. 16. MV Portfolio for South Korea---Borrowing.**

Figures 15 and 16 show the borrowing level for South Korean SF and MV portfolio. They show similar patterns. The borrowing rates for both portfolios have decreased in both the Asian and the Financial Crisis. However, SF portfolio has a higher level of borrowing rate than MV portfolio. For MV portfolio, there are several peaks for the borrowing level, especially the one in 2007.

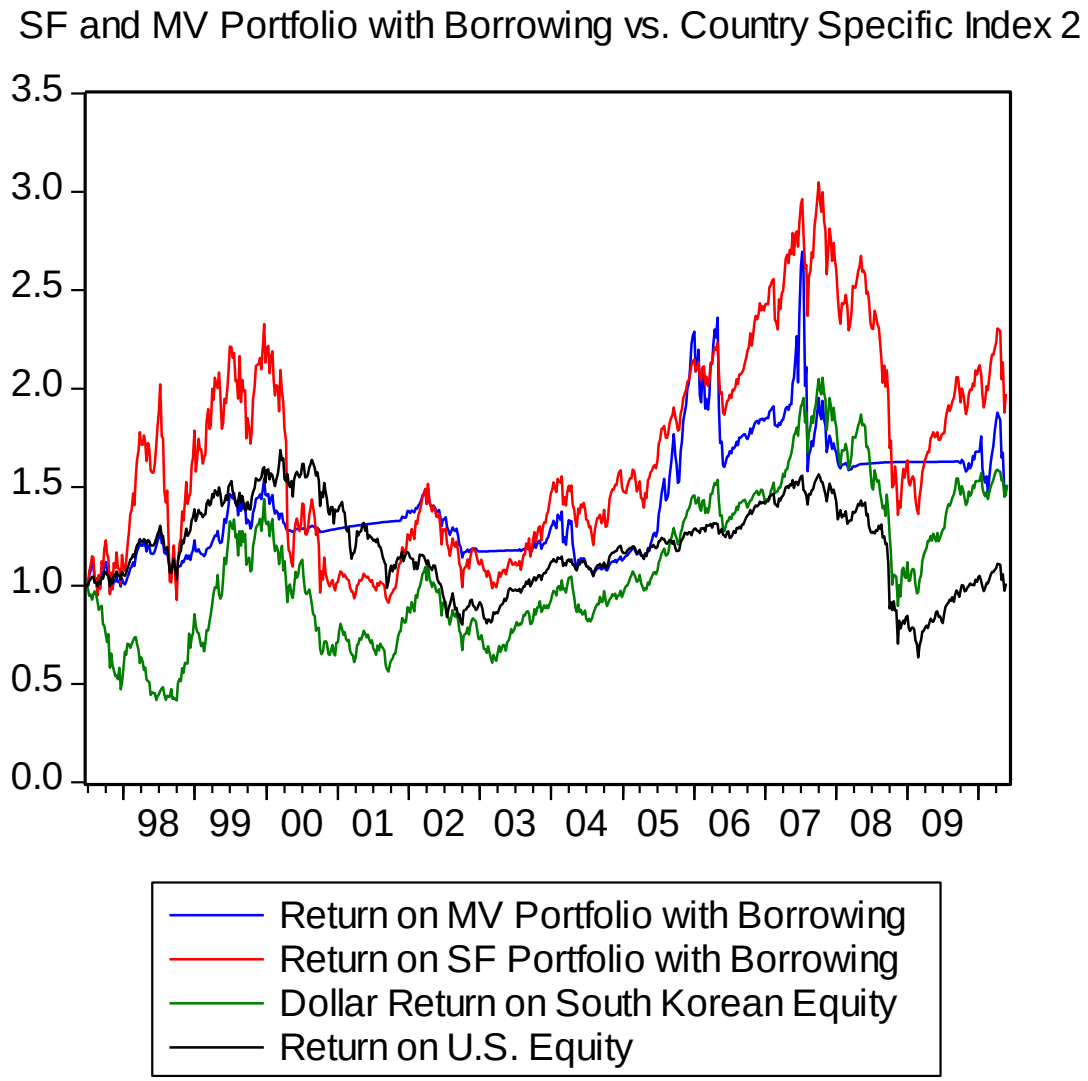


**Fig. 17. SF and MV Portfolio with Borrowing vs. Country Specific Index 2.**

Figure 17 demonstrates the SF and MV portfolios with borrowing and hold and buy Equity's performance for South Korea. If an investor just invests in the South Korean equity wealth will decrease to 44% of its initial value in Oct., 1998 during the Asian crisis. By Apr. 1999, the South Korean equity has recovered to its initial value. During

the IT Bubble Bust, both South Korean and U.S equity have suffered great loss in equity value. Before the Financial Crisis, South Korean equity showed an increasing trend, and outperforms U.S. equity although it also suffers a sharp loss during the Financial Crisis, it recovers soon after that, and has a relatively faster recovery rate than U.S. equity, and South Korean equity reaches 160% of its initial wealth at the end of the sample. Now look at the portfolio with borrowing. From the graph we can see that the SF portfolio investor earns a return higher than the MV portfolio investor, especially during the Asian Crisis and the Financial Crisis. From Table 2, it indicates that the SF portfolio outperforms the MV portfolio during the Asian Crisis, Period after Asian Crisis, Period after IT Bubble Bust, and period after Financial Crisis, But for other periods, MV outperforms, However, at the end of the sample, the SF portfolio rise to the 196% of its initial wealth level, the MV wealth level rises to 151% of its initial wealth level.

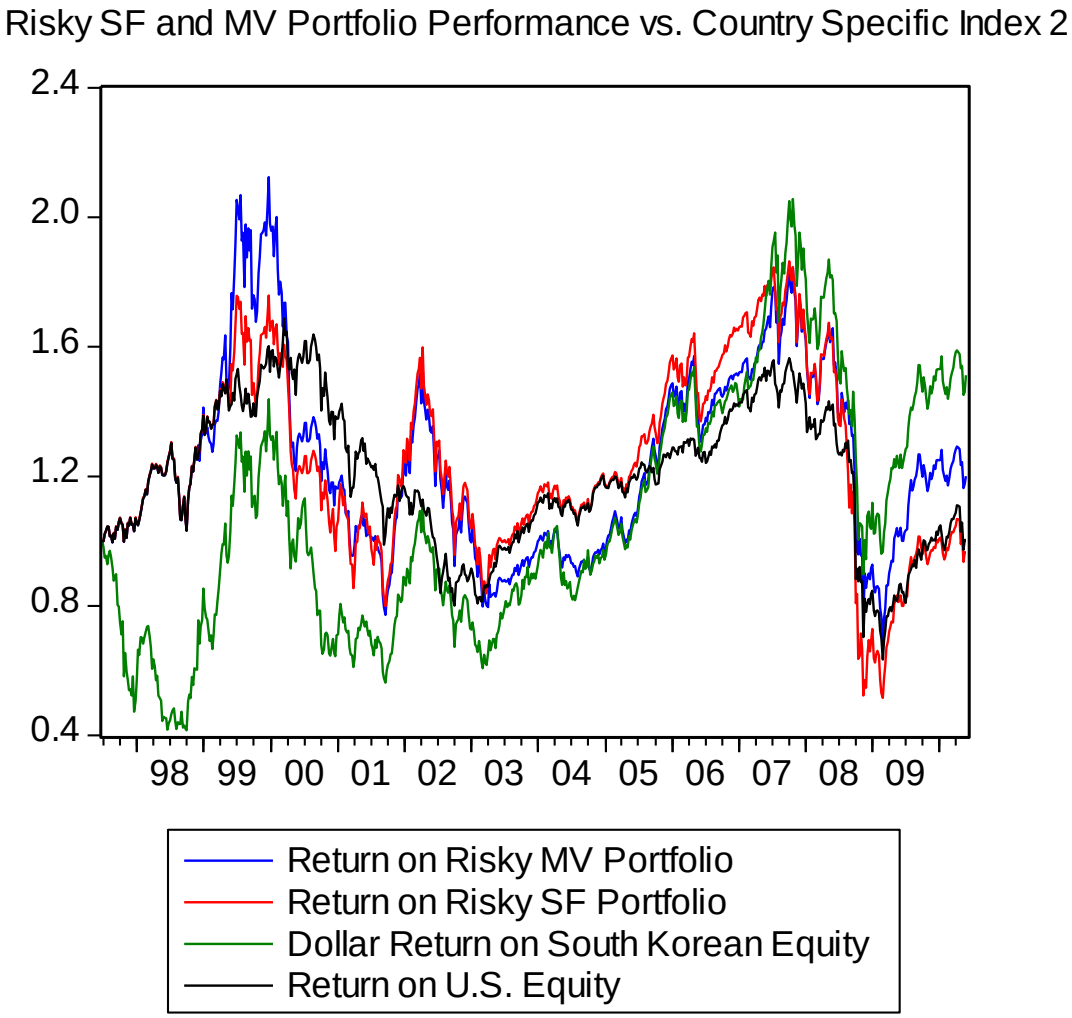


**Fig. 18. Risky SF and MV Portfolio Performance vs. Country Specific Index 2.**

Figure 18 demonstrates the risky SF and MV portfolios and hold and buy Equity's performance for South Korea. We can see without leverage, risky SF portfolio works not as well as the portfolio with borrowing. From Table 3, we can see that risky SF portfolio

outperforms risky MV portfolio for period after Asian Crisis, IT Bubble Bust and period after the Financial Crisis.

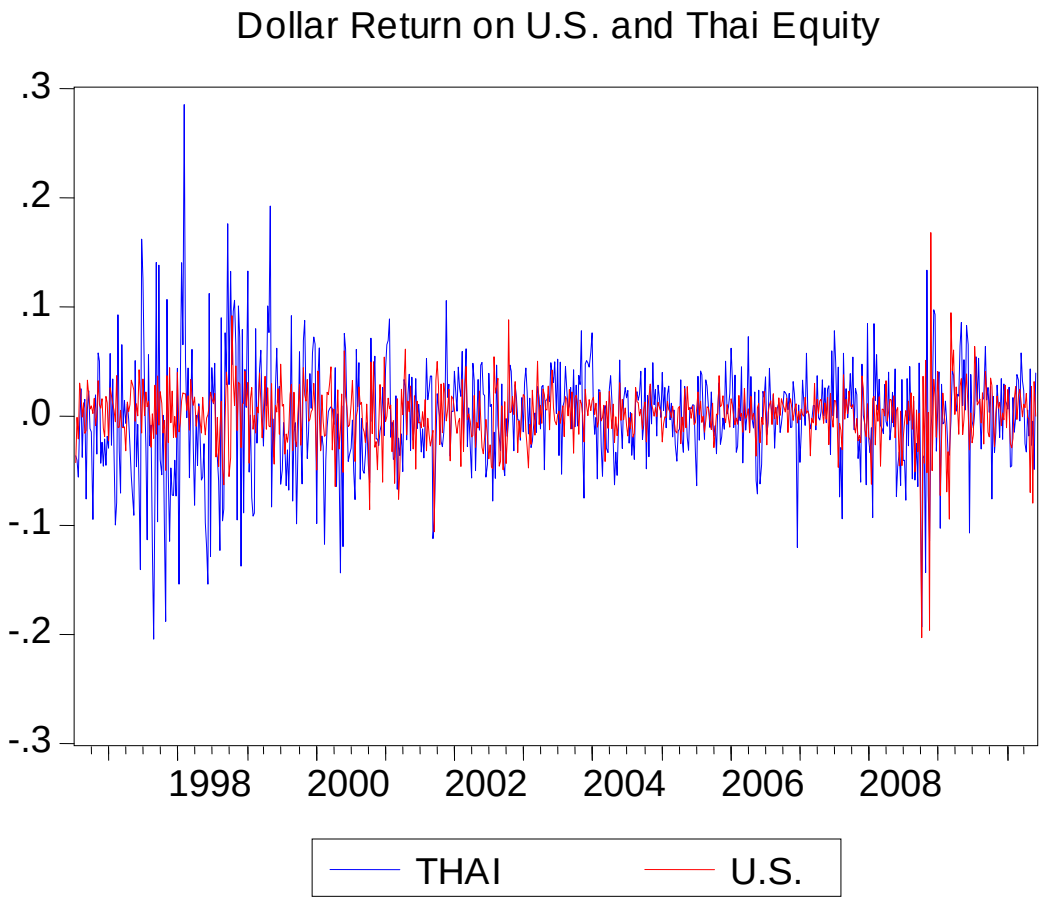


**Fig. 19. Dollar Return on U.S. and Thai Equity.**

Figure 19 shows the comparison between of the dollar return on Thai equity and the U.S. equity return. We can pick up two separate parts to look at from the entire sample, the first part starts in mid-1997, ends 2002, which is also the period of Asian-Crisis. It

shows a great increase in the volatility of Thai equity. During 1998 to late 1999, there is great fluctuation on Thai dollar return. The 2nd part is the Financial Crisis starting in Aug. 2007 till the end. The U.S. equity show relatively large volatility than Thai equity. The mean return of U.S equity is significantly higher than the mean return of Thai equity. And the Thai equity has a higher standard deviation.

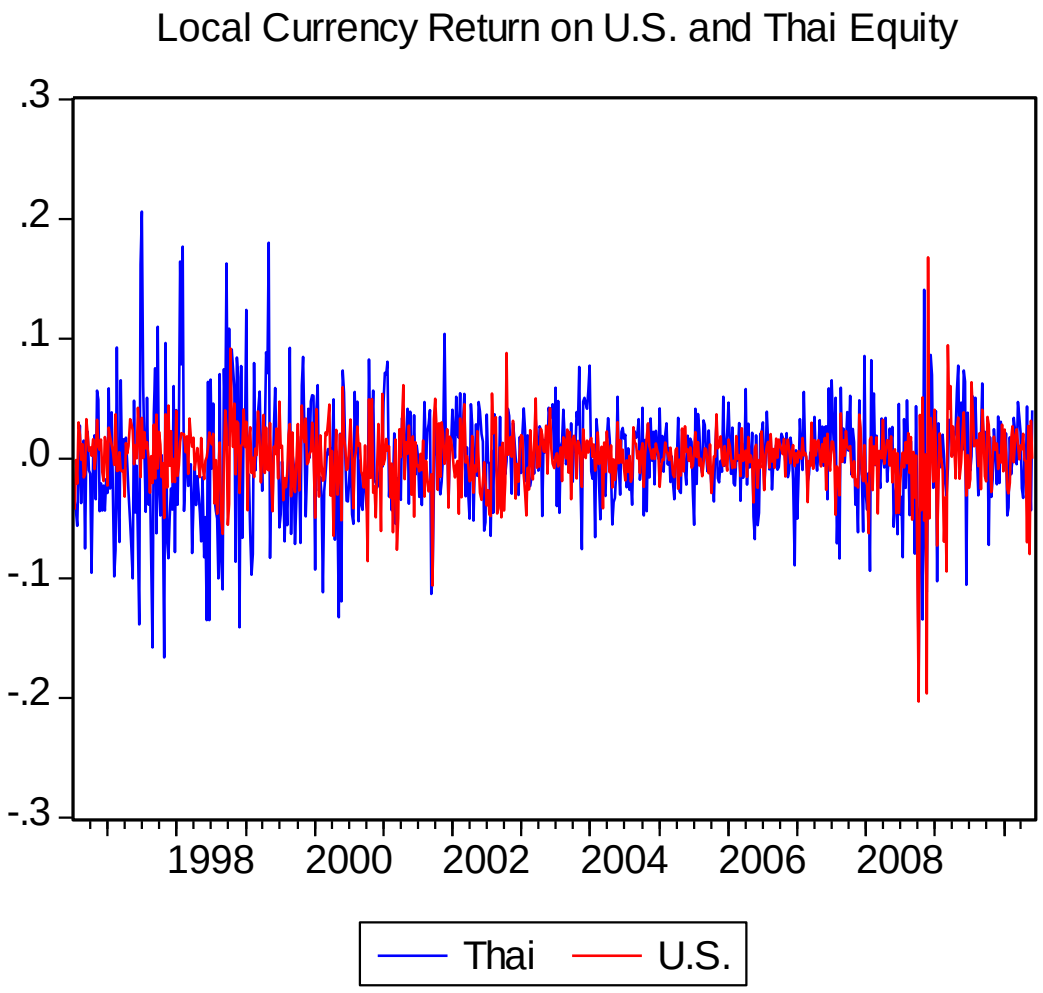


**Fig. 20. Local Currency Return on U.S. and Thai Equity.**

Figure 20 shows the local currency returns on Thai and U.S. equity. Over the entire sample, the Thai equity shows more volatility than U.S. equity during the Asian Crisis, while the return of U.S. equity shows a higher volatility during the Financial Crisis. However, the local currency return of Thai equity shows a relatively low volatility compared to dollar return.

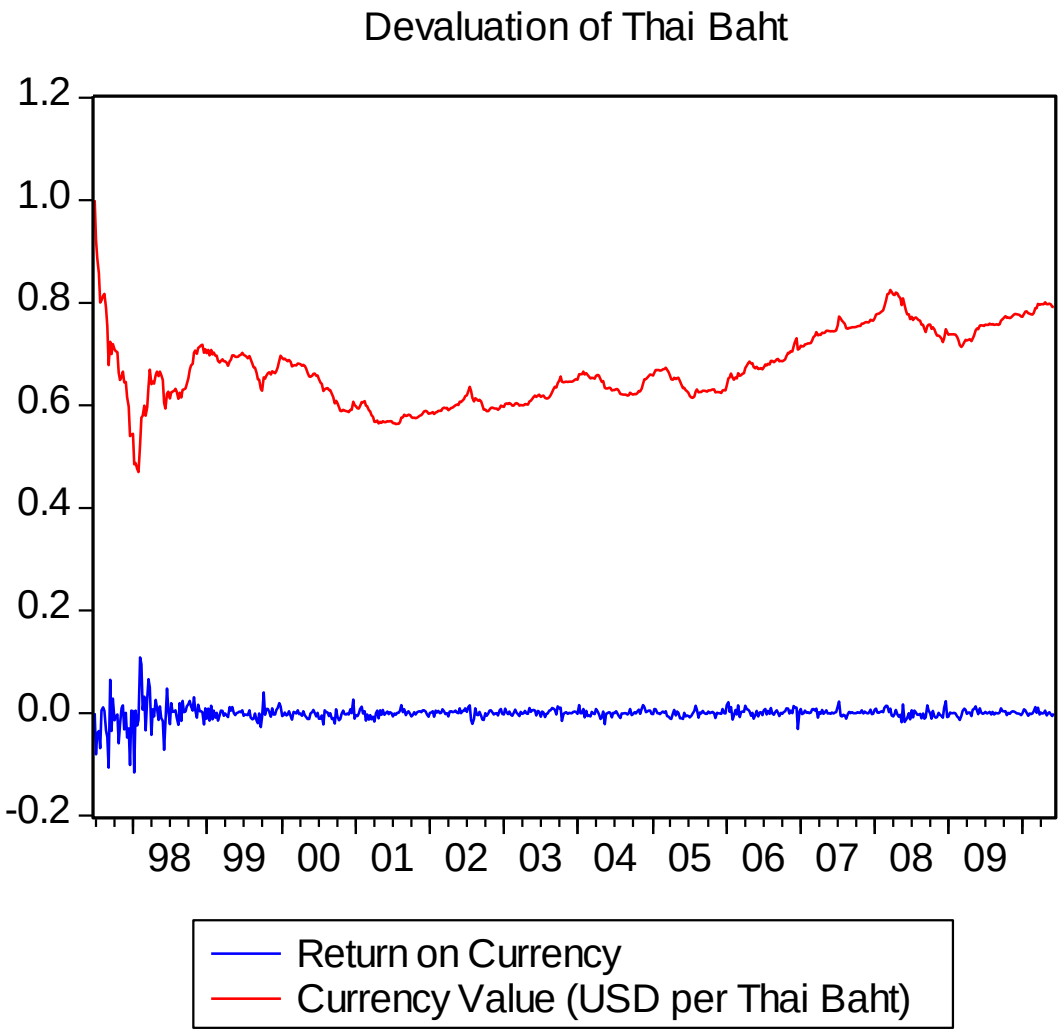


**Fig. 21. Devaluation of Thai Baht.**

Figure 21 shows the behavior of Thai spot exchange rate, it has a great depreciation of Thai Baht during Asian Crisis. But it shows a recovery to 60% level of the initial level. The currency value shows a steady increasing trend beginning from 2000 until late 2007. It suffers a subtle depreciation during the Financial Crisis, but recovered in early 2009.

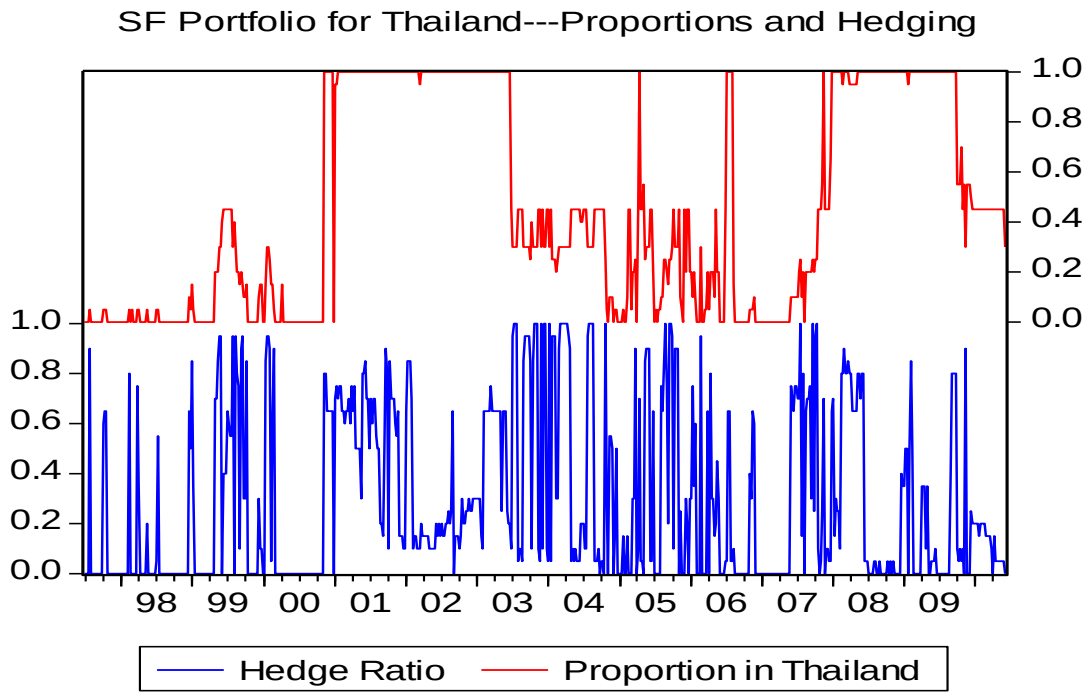


**Fig. 22. SF Portfolio for Thailand---Proportions and Hedging**.

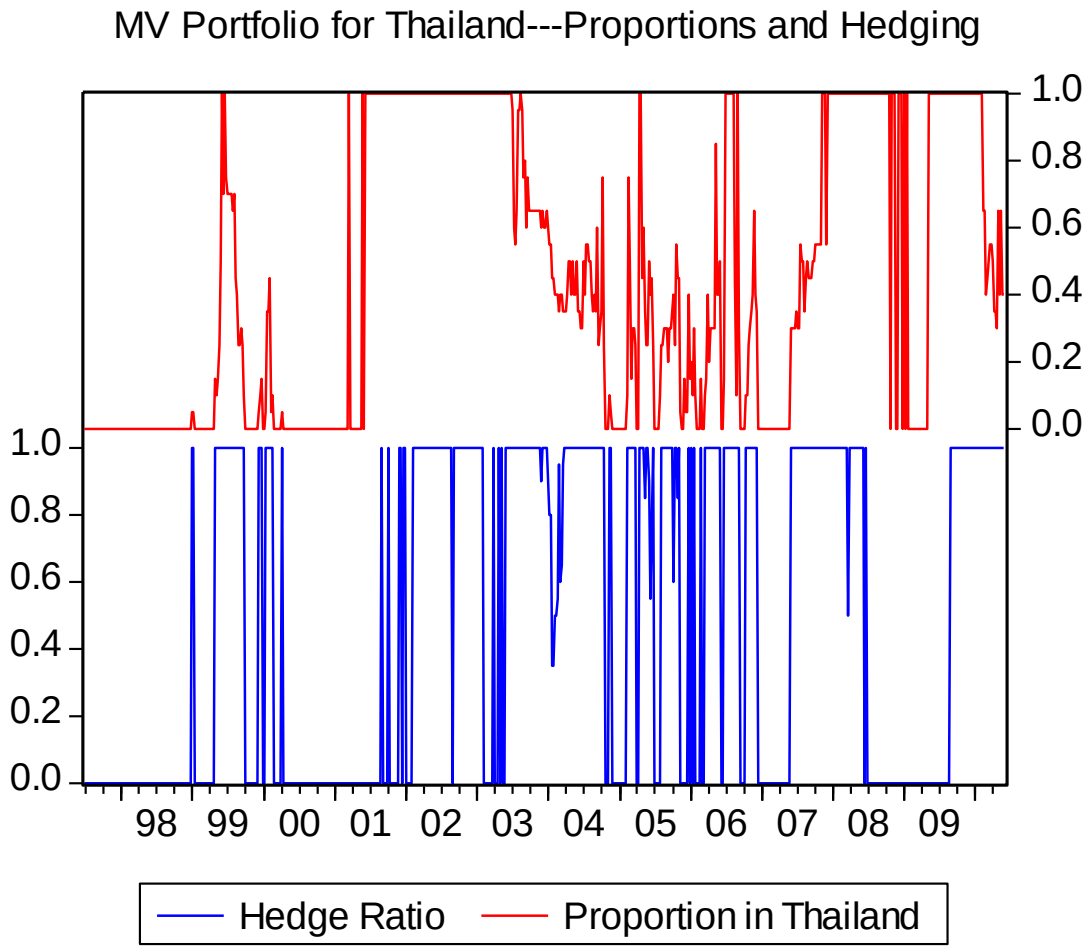


**Fig. 23. MV Portfolio for Thailand---Proportions and Hedging.**

Figures 22 and 23 show the optimal SF and MV portfolio investment proportions and hedge ratios combinations for portfolio including Thai equity. They have a similar pattern also. For SF portfolio, till early 1999, there is almost no investment on Thai equity, even when the investor holds some Thai equity that will be heavily hedged. From late 1998 to late 1999, investment proportion on Thai equity is increasing with heave hedge ratio. During 2000, there is no proportion invested in Thai equity. From late 2000

until 2003, there is almost complete investment on Thai equity. Beginning 2004, there is volatile proportion invested in Thai equity but with a higher hedge ratio until early 2006. And look at the period of Financial Crisis, during the late 2007 till the beginning of 2009, Thai equity is heavily invested and with relatively low hedging ratio. And at the end of the sample, the investment proportion decreased with increased hedging ratio. For MV portfolio, it shows a higher hedge ratio than SF portfolio.

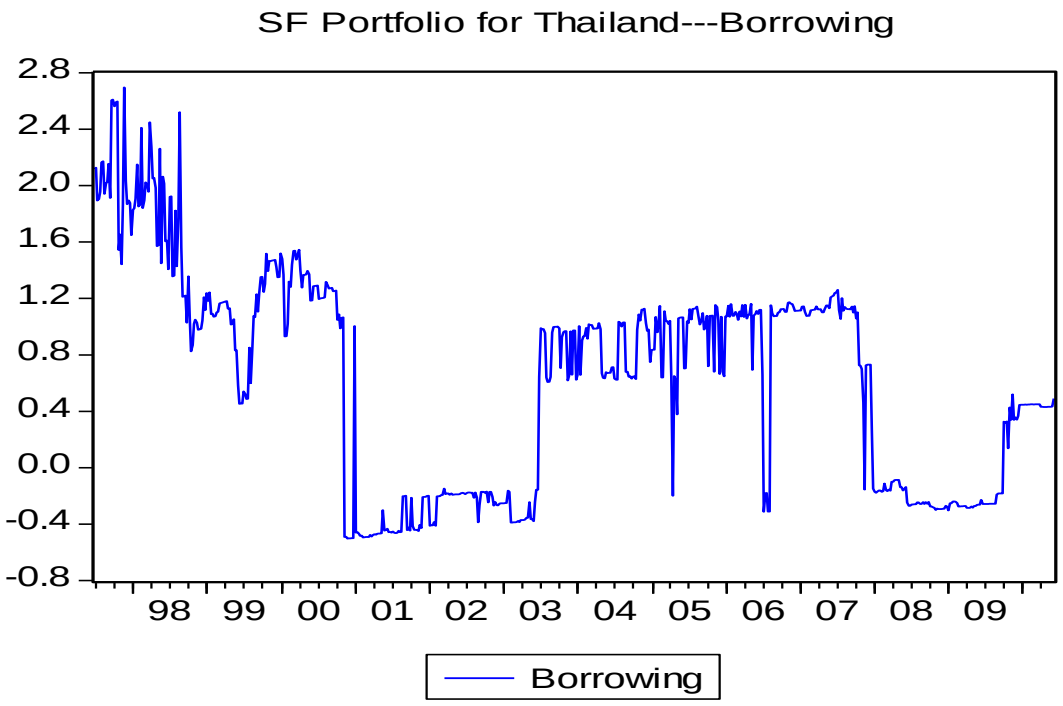


**Fig. 24. SF Portfolio for Thailand---Borrowing.**

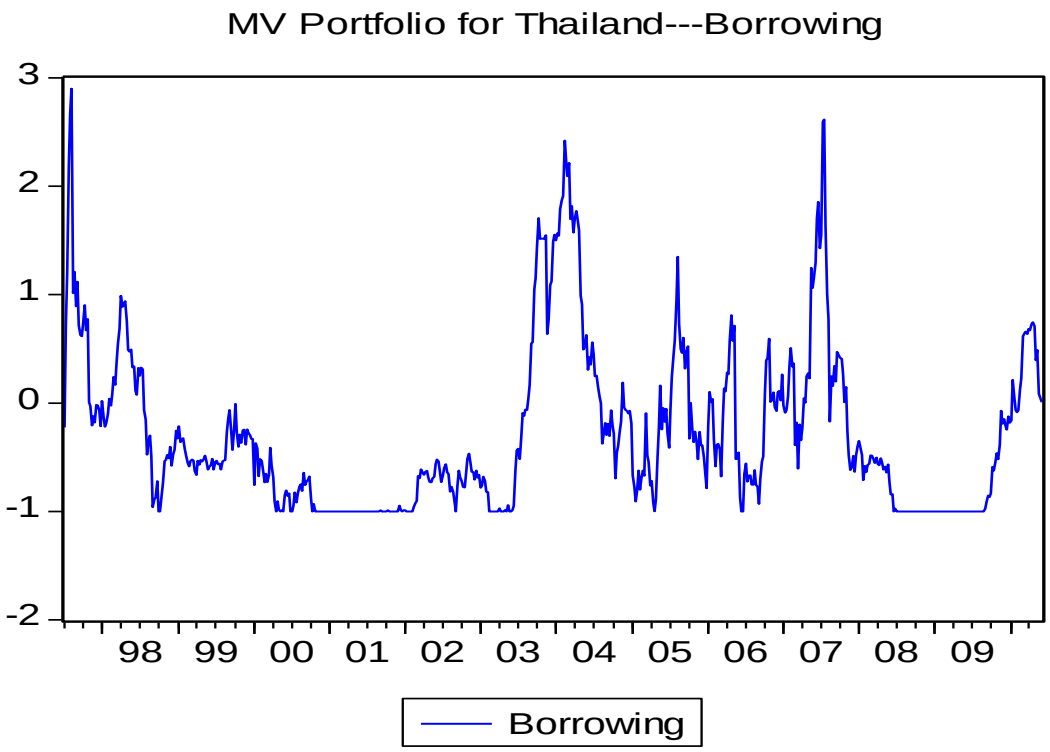


**Fig. 25. MV Portfolio for Thailand---Borrowing.**

Figures 24 and 25 show the borrowing level, the SF and MV also show a similar pattern. For SF the initial level begins around 2.2, but decrease below 0 in 1998, later increased to 1.2 but later plunged sharply on Oct, 1999, the similar situation repeats during 1999 and late 2000. It shows a great fluctuation. And during 2000 and 2003, the borrowing level is low, after that, the leverage level bounce around at level 0.8, although there are 7 times sharp decrease during this period, but recovered to previous level quickly. During the Financial Crisis, the borrowing level decreased to below 0 and increased to 0.4 at the end of the sample. For MV portfolio, it shows an obvious peak and trough structure.

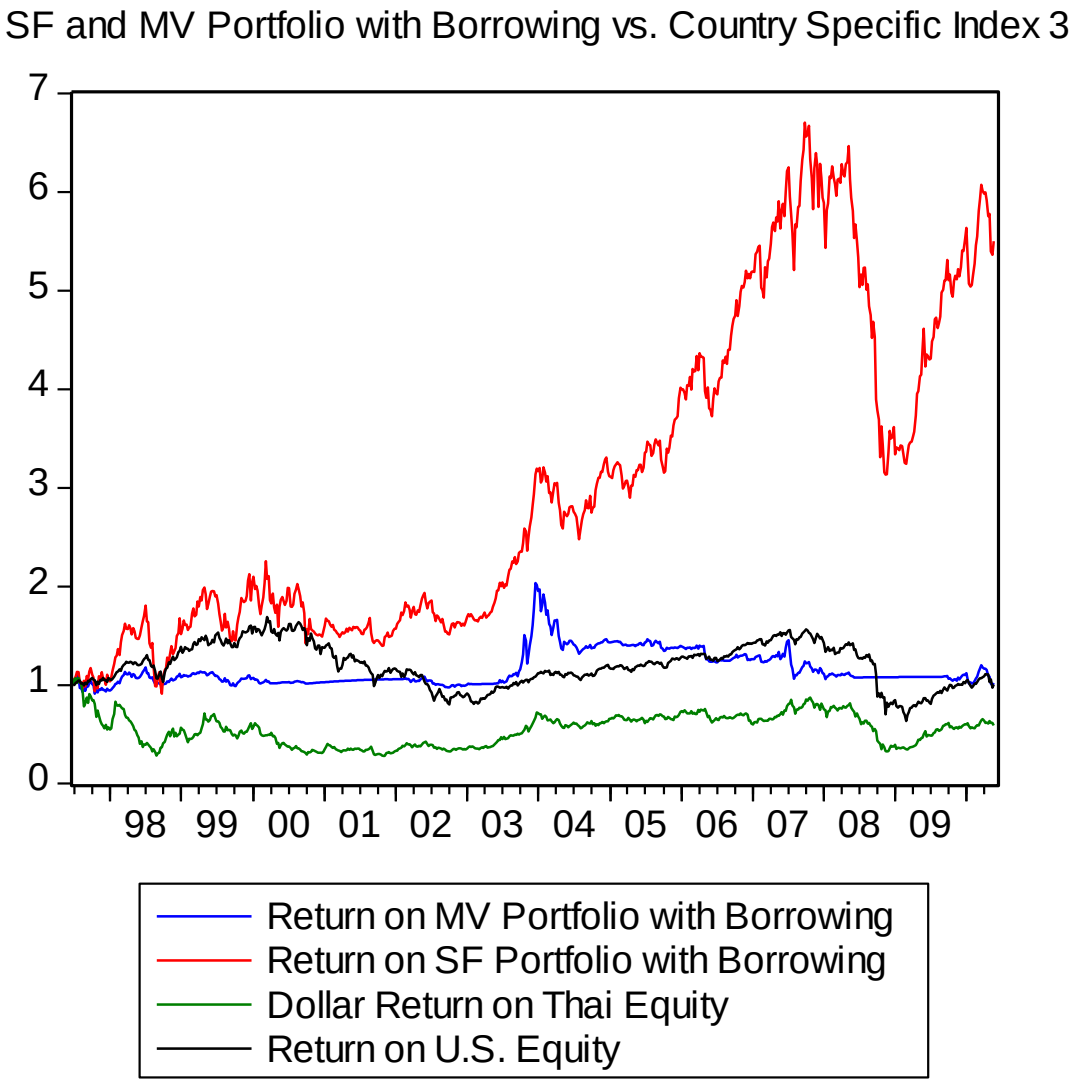


**Fig. 26. SF and MV Portfolio with Borrowing vs. Country Specific Index 3.**

Figure 26 shows the comparison among different investment portfolio strategies for Thailand, including the dollar return of risky part on SF portfolio with borrowing, the dollar return of MV portfolio with borrowing, also suppose the buy and hold strategy. If an investor just invests in the Thai equity, the wealth will decrease to 40% of its initial value during the Asian crisis. Note that the U.S. equity decreased sharply during the IT Bubble Bust and during the Financial Crisis. From Figure 26 we can see that the SF portfolio with borrowing outperforms the MV portfolio with borrowing for the whole period. At the end of the sample period, the SF portfolio rise to the 536% of its initial wealth level, the MV wealth level rises to 102% of its initial wealth level. Holding the SF portfolio has the highest wealth at the end. Look at Table 3 for sub-period return, the SF portfolio outperforms MV portfolio during Asian Crisis, period after Asian Crisis, period after IT Bubble Bust and period after Financial Crisis.

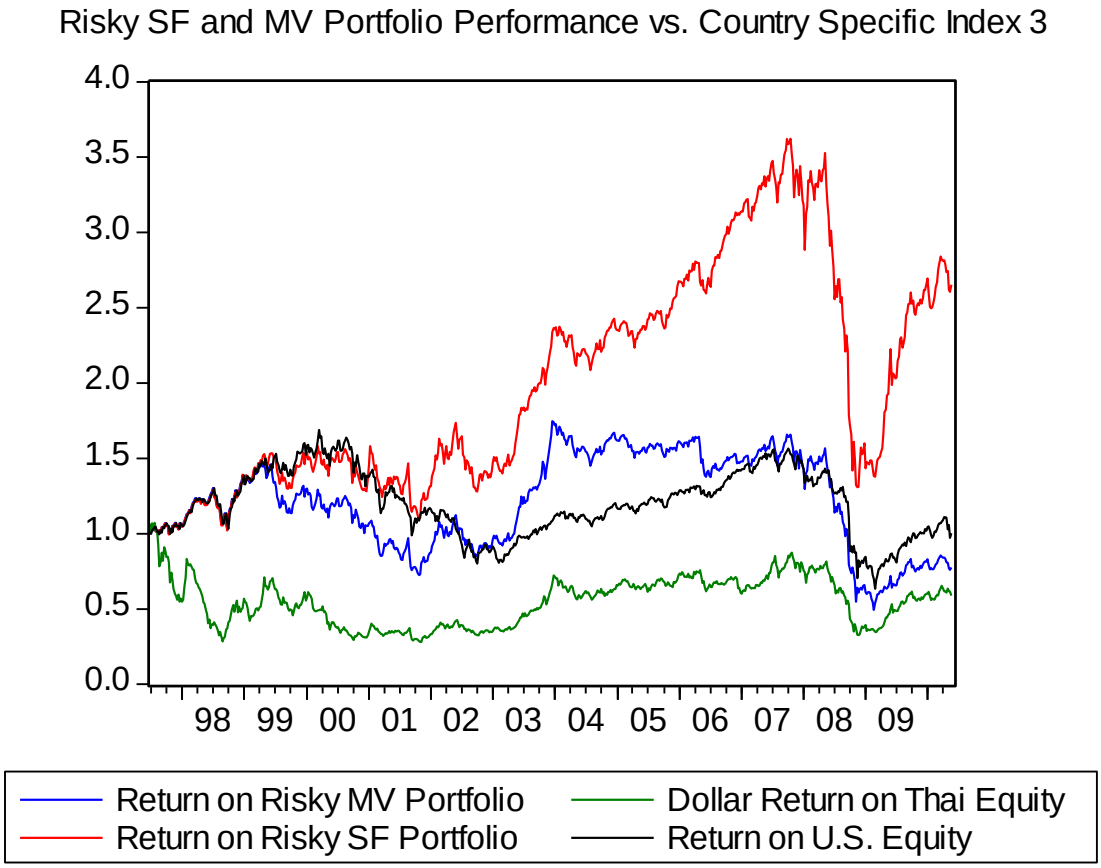


**Fig. 27. Risky SF and MV Portfolio Performance vs. Country Specific Index 3.**

Figure 27 demonstrates the risky SF and MV portfolios and hold and buy Equity's performance for Thailand. Without leverage both of them indicate lower wealth level. However, risky SF portfolio investor will have a higher wealth level than risky MV portfolio investor, and even has a higher return for each sub-period.

Table 2: Whole Portfolio Performance vs. Country Specific Index (52 MA, s=0.8)

| | Indonesia | South Korea | Thailand | US |
|---|---|---|---|---|
| **Asian Crisis(Jul.3,97--Dec.30,99)** | | | | |
| SF_borrow | 0.2237 | 0.2135 | 0.1899 | |
| MV_borrow | 0.0078 | 0.1042 | 0.0220 | |
| Buy and Hold | -0.0329 | 0.0869 | -0.1176 | 0.1139 |
| **Period after Asian Crisis (Jan.6,00-Mar.2,00)** | | | | |
| SF_borrow | -0.2085 | 0.1578 | -0.0954 | |
| MV_borrow | -0.2426 | 0.0475 | -0.1147 | |
| Buy and Hold | -0.4977 | 0.0498 | -0.5189 | 0.033 |
| **IT Bubble Bust(Mar.9,00--Oct.10,02)** | | | | |
| SF_borrow | -0.0822 | -0.1268 | -0.0624 | |
| MV_borrow | -0.0276 | -0.0299 | -0.0107 | |
| Buy and Hold | -0.1595 | -0.0945 | -0.0822 | -0.1347 |
| **Period after IT Bubble Bust** | | | | |
| SF_borrow | 0.2090 | 0.1203 | 0.1695 | |
| MV_borrow | 0.0396 | 0.1004 | 0.0258 | |
| Buy and Hold | 0.2174 | 0.1227 | 0.1224 | 0.0661 |
| **Financial Crisis(Aug.16,07--April.02,09)** | | | | |
| SF_borrow | -0.0538 | -0.1273 | -0.1577 | |
| MV_borrow | -0.0264 | 0.0104 | 0.0059 | |
| Buy and Hold | -0.1237 | -0.1227 | -0.2007 | -0.1912 |
| **Period after Financial Crisis(Apr.2.09-- Jun.03.10)** | | | | |
| SF_borrow | 0.2314 | 0.1037 | 0.2499 | |
| MV_borrow | 0.0398 | -0.0352 | -0.0276 | |
| Buy and Hold | 0.3277 | 0.1403 | 0.2554 | 0.1378 |
| **The Whole Sample(Jul.3.97—Jun.03.10)** | | | | |
| SF_borrow | 0.0901 | 0.0305 | 0.0788 | |
| MV_borrow | -0.0005 | 0.0185 | 0.0009 | |
| Buy and Hold | 0.0161 | 0.0186 | -0.0233 | 0.0001 |

* Portfolio Returns with borrowing are calculated by reinvested method.

*In calculation of the performance index, the Domestic and foreign securities returns, spot exchange returns used to obtain the results are all calculated based on 52 weeks moving average, but not for the interest rate parity, and with 0.8 as the disaster level.

Table 3: Risky Portfolio Performance vs. Country Specific Index (52 MA, s=0.8)

| | Indonesia | South Korea | Thailand | US |
|---|---|---|---|---|
| **Asian Crisis(Jul.3,97--Dec.30,99)** | | | | |
| SF_risky | 0.1191 | 0.1380 | 0.1649 | |
| MV_risky | 0.0315 | 0.1883 | 0.0659 | |
| Buy and Hold | -0.0329 | 0.0869 | -0.1176 | 0.1139 |
| **Period after Asian Crisis (Jan.6,00-Mar.2,00)** | | | | |
| SF_risky | -0.0600 | 0.0855 | -0.0494 | |
| MV_risky | -0.3750 | 0.0312 | -0.1728 | |
| Buy and Hold | -0.4977 | 0.0498 | -0.5189 | 0.033 |
| **IT Bubble Bust(Mar.9,00--Oct.10,02)** | | | | |
| SF_risky | -0.1029 | -0.0816 | -0.0357 | |
| MV_risky | -0.1762 | -0.1121 | -0.0694 | |
| Buy and Hold | -0.1595 | -0.0945 | -0.0822 | -0.1347 |
| **Period after IT Bubble Bust** | | | | |
| SF_risky | 0.1695 | 0.0642 | 0.1165 | |
| MV_risky | 0.1189 | 0.0685 | 0.0747 | |
| Buy and Hold | 0.2174 | 0.1227 | 0.1224 | 0.0661 |
| **Financial Crisis(Aug.16,07--April.02,09)** | | | | |
| SF_risky | -0.2609 | -0.2561 | -0.2316 | |
| MV_risky | -0.3256 | -0.1839 | -0.2657 | |
| Buy and Hold | -0.1237 | -0.1227 | -0.2007 | -0.1912 |
| **Period after Financial Crisis(Apr.2.09-- Jun.03.10)** | | | | |
| SF_risky | 0.3860 | 0.1756 | 0.3139 | |
| MV_risky | 0.3094 | 0.1725 | 0.1329 | |
| Buy and Hold | 0.3277 | 0.1403 | 0.2554 | 0.1378 |
| **The Whole Sample(Jul.3.97—Jun.03.10)** | | | | |
| SF_risky | 0.0367 | -0.0002 | 0.0444 | |
| MV_risky | -0.0372 | 0.0082 | -0.0113 | |
| Buy and Hold | 0.0161 | 0.0186 | -0.0233 | 0.0001 |

*Risky Portfolio Returns are calculated by reinvested method.

*In calculation of the performance index, the Domestic and foreign securities returns, spot exchange returns used to obtain the results are all calculated based on 52 weeks moving average, but not for the interest rate parity, and with 0.8 as the disaster level.

# CHAPTER VI

## DATA SOURCE

Data are selected on weekly basis; the variables needed here are domestic stock index, foreign stock index, spot exchange rate and interest rate for U.S., Indonesia, South Korea and Thailand. For Indonesian and U.S., there are 1020 observations beginning on Nov. 22 1990, South Korea has 879 observations dating from Aug. 5 1993. Thailand has 727 observations dating from Jul. 4 1996. Data selection for each country all end on Jun. 03 2010.

The data are obtained from Datastream, it's a financial statistical database. For the country specific stock index is Datastream calculated price index in local currency, with dividend reinvested. The spot exchange rate is obtained as the foreign currency to US $. The interest rate for each countries are different, they are selected according to the term-matching principle the availability on Datastream. For Indonesia, the interbank call rate is used; for South Korea, it's the overnight call rate; for Thailand, The interbank call rate is used; and for U.S., the Euro-dollar one week call rate is used. The risk free rate used is the 3-month Treasury bill rate.

# CHAPTER VII

# CONCLUSIONS

This thesis has tested the SF approach during a long term investment period with hedging and borrowing/lending, compared to MV approach, the results show that the SF portfolio has a better performance than MV portfolio and buy and hold portfolios. Safety SF portfolio has limited the downside risk, it is a good investment reference to take especially when there is great loss or the probability of rare events in financial markets.

Hedging and borrowing are also important, hedging can lock the risk of foreign exchange rate, and borrowing can take advantage of the bull market trend by heavily invested in risky portfolio, and decrease the loss of wealth in bear market by investing in risk free equity.

In this study MV approach does not work well over this period of repeated financial crisis, perhaps this is due to the lack of adjustment for downside risk. Future work might consider the semi-variance methods, and compare those to SF approach.

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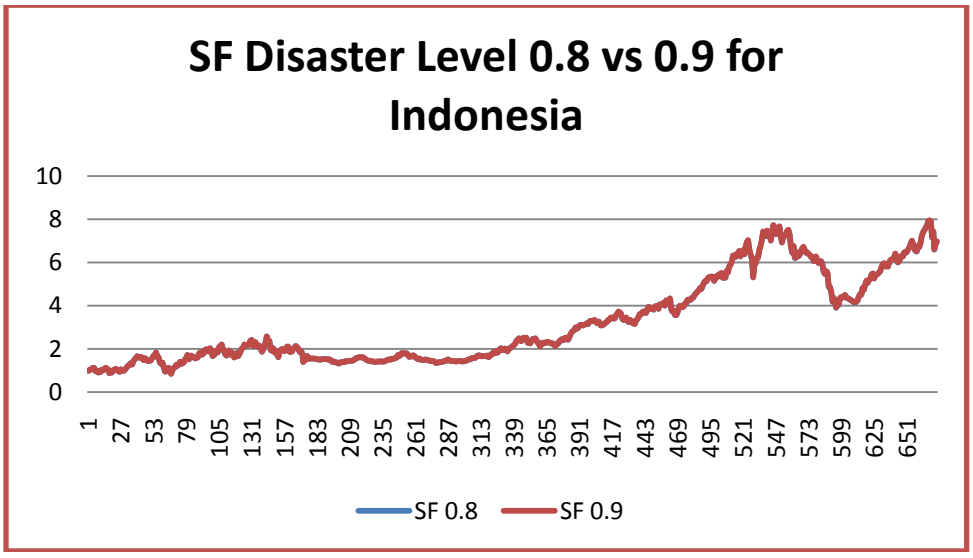
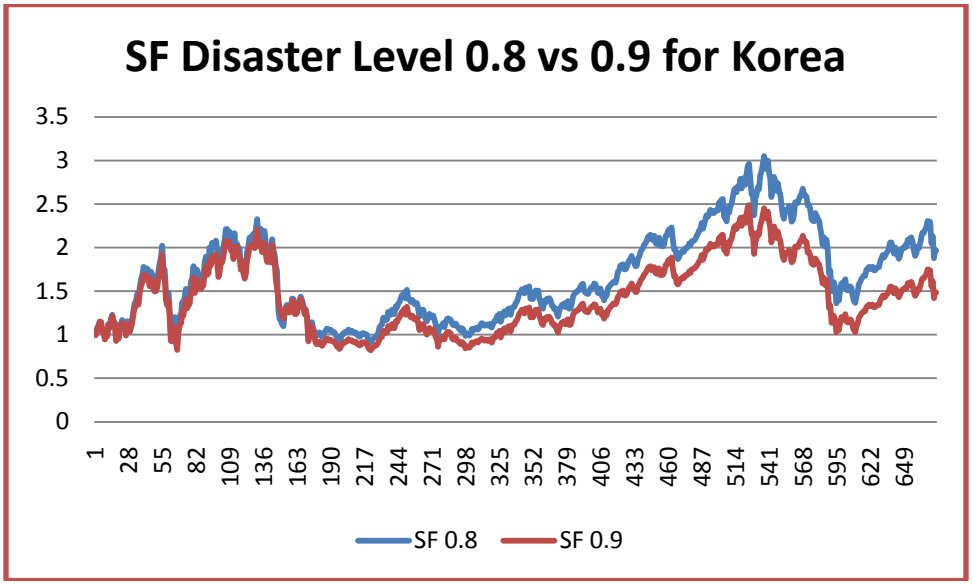
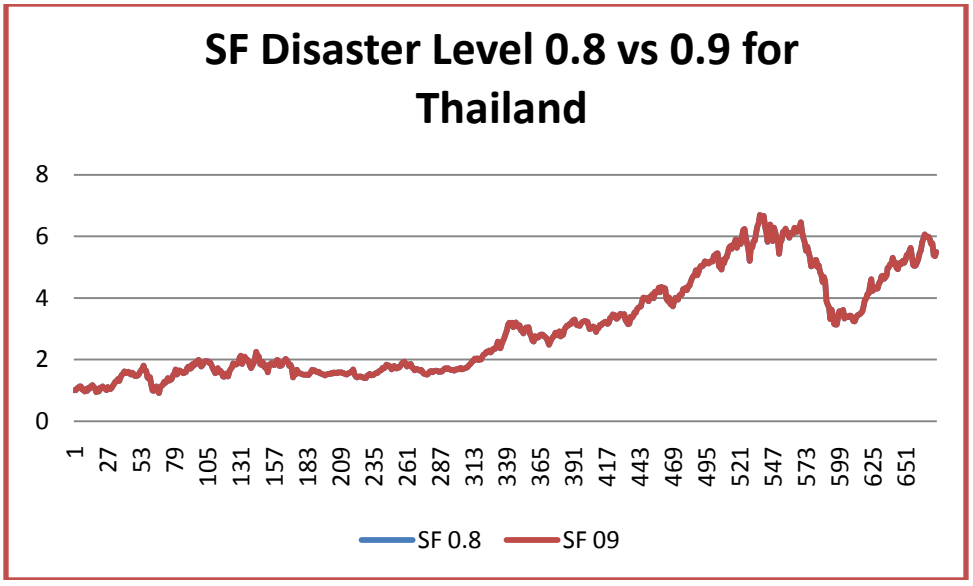
# APPENDIX A

When apply the SF Theory, the disaster level is taken as constant, there is no adjustment on the people's expectation change with the risk. Suppose the disaster levels are 10% and 20%. So respectively, make s=0.8 and s=0.9 to calculate the return on Portfolio with borrowing. The results show the different parameter's values only have created slight difference in wealth level, and for Indonesia and Thailand, the difference are not visible from the graph.




SF Disaster Level 0.8 vs 0.9 for Thailand
8
6
4
2
0
1
27
53
79
105
131
157
183
209
235
261
287
313
339
365
391
417
443
469
495
521
547
573
599
625
651
SF 0.8
SF 09

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